ATKINS

Wake County, NC

Wake County Multi-Jurisdictional Hazard Mitigation Plan

FINAL

Plan Design Enable

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SECTION 1
INTRODUCTION

This section provides a general introduction to the Wake County Multi-Jurisdictional Hazard Mitigation Plan. It consists of the following five subsections:

- 1.1 Background
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- 1.4 Authority
- 1.5 Summary of Plan Contents

1.1 BACKGROUND

Natural hazards, such as floods, hurricanes and winter storms are a part of the world around us. Their occurrence is natural and inevitable, and there is little we can do to control their force and intensity. We must consider these hazards to be legitimate and significant threats to human life, safety, and property.

Wake County is located in the eastern portion of the Piedmont area of North Carolina. The County includes the Town of Apex, Town of Cary, Town of Fuquay-Varina, Town of Garner, Town of Holly Springs, Town of Knightdale, Town of Morrisville, City of Raleigh, Town of Rolesville, Town of Wake Forest, Town of Wendell, Town of Zebulon, and all unincorporated areas within the county. This area is vulnerable to a wide range of natural hazards such as hurricanes, floods, severe thunderstorms, and tornados. It is also vulnerable to human-caused hazards, including nuclear accidents and hazardous material spills. These hazards threaten the life and safety of residents in the Wake County and have the potential to damage or destroy both public and private property, disrupt the local economy, and impact the overall quality of life of individuals who live, work, and vacation in Wake County.

While the threat from hazardous events may never be fully eliminated, there is much we can do to lessen their potential impact upon our community and our citizens. By minimizing the impact of hazards upon our built environment, we can prevent such events from resulting in disasters. The concept and practice of reducing risks to people and property from known hazards is generally referred to as *hazard mitigation*.

FEMA Definition of Hazard Mitigation:
"Any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards."

Hazard mitigation techniques include both structural measures (such as strengthening or protecting buildings and infrastructure from the destructive forces of potential hazards) and non-structural measures (such as the adoption of sound land use policies and the creation of public awareness programs). It is widely accepted that the most effective mitigation measures are implemented at the local government level, where decisions on the regulation and control of development are ultimately made. A comprehensive mitigation approach addresses hazard vulnerabilities that exist today and in the foreseeable future. Therefore, it is essential that projected patterns of future development are evaluated and considered in terms of how that growth will increase or decrease a community's overall hazard vulnerability.

A key component in the formulation of a comprehensive approach to hazard mitigation is to develop, adopt, and update a local hazard mitigation plan as needed. A hazard mitigation plan establishes the broad community vision and guiding principles for reducing hazard risk, and further proposes specific mitigation actions to eliminate or reduce identified vulnerabilities.

The county and each of the twelve municipalities participating in the development of the Wake County Multi-Jurisdictional Hazard Mitigation Plan have an existing hazard mitigation plan that has evolved over the years, as described in Section 2: *Planning Process*. This multi-jurisdictional plan draws from each of the previous plans to document the efforts of each jurisdiction to incorporate hazard mitigation principles and practices into routine government activities and functions. *At its core, the Plan recommends specific actions to minimize hazard vulnerability and protect residents from losses to those hazards that pose the greatest risk.* These mitigation actions go beyond simply recommending structural solutions to reduce existing vulnerability, such as elevation, retrofitting, and acquisition projects. Local policies on community growth and development, incentives for natural resource protection, and public awareness and outreach activities are examples of other actions considered to reduce Wake County's vulnerability to identified hazards. The Plan remains a living document, with implementation and evaluation procedures established to help achieve meaningful objectives and successful outcomes over time.

1.1.1 The Disaster Mitigation Act and the Flood Insurance Reform Acts

In an effort to reduce the Nation's mounting natural disaster losses, the U.S. Congress passed the Disaster Mitigation Act of 2000 (DMA 2000) in order to amend the Robert T. Stafford Disaster Relief and Emergency Assistance Act. Section 322 of DMA 2000 emphasizes the need for state, local and Tribal government entities to closely coordinate on mitigation planning activities and makes the development of a hazard mitigation plan a specific eligibility requirement for any local or Tribal government applying for federal mitigation grant funds. In short, if a jurisdiction is not covered by an approved mitigation plan, it will not be eligible for mitigation grant funds. These funds include the Hazard Mitigation Grant Program (HMGP) and the Pre-Disaster Mitigation (PDM) program, both of which are administered by the Federal Emergency Management Agency (FEMA) under the Department of Homeland Security. Communities with an adopted and federally-approved hazard mitigation plan thereby become pre-positioned and more apt to receive available mitigation funds before and after the next disaster strikes.

Additionally, the Flood Insurance Reform Act of 2004 (P.L. 108-264) created two new grant programs, Severe Repetitive Loss (SRL) and Repetitive Flood Claim (RFC), and modified the existing Flood Mitigation Assistance (FMA) program. One of the requirements of this Act is that a FEMA-approved Hazard Mitigation Plan is now required if communities wish to be eligible for these FEMA mitigation programs. However, as of early 2014, these programs have been folded into a single Flood Mitigation Assistance (FMA) program.

This change was brought on by new, major federal flood insurance legislation that was passed in 2012 under the Biggert-Waters Flood Insurance Reform Act (P.L. 112-141) and the subsequent Homeowner

Flood Insurance Affordability Act in 2014 which revised Biggert-Waters. These acts made several changes to the way the National Flood Insurance Program is to be run, including raises in rates to reflect true flood risk and changes in how Flood Insurance Rate Map (FIRM) updates impact policyholders. These acts further emphasize Congress' focus on mitigating vulnerable structures.

The Wake County Multi-Jurisdictional Hazard Mitigation Plan has been prepared in coordination with FEMA Region IV and the North Carolina Division of Emergency Management (NCEM) to ensure that the Plan meets all applicable FEMA and state requirements for hazard mitigation plans. A *Local Mitigation Plan Review Tool*, found in Appendix C, provides a summary of federal and state minimum standards and notes the location where each requirement is met within the Plan.

1.2 PURPOSE

The purpose of the Wake County Multi-Jurisdictional Hazard Mitigation Plan is to:

- Merge the existing Wake County, Town of Apex, Town of Cary, Town of Fuquay-Varina, Town of Garner, Town of Holly Springs, Town of Knightdale, Town of Morrisville, City of Raleigh, Town of Rolesville, Town of Wake Forest, Town of Wendell, and Town of Zebulon hazard mitigation plans into one multi-jurisdictional plan;
- Complete update of existing plans to demonstrate progress and reflect current conditions;
- Increase public awareness and education about the plan and the planning process;
- Maintain grant eligibility for participating jurisdictions; and
- Maintain compliance with state and federal legislative requirements for local hazard mitigation plans.

1.3 SCOPE

The focus of the Wake County Multi-Jurisdictional Hazard Mitigation Plan is on those hazards determined to be "high" or "moderate" risks to Wake County, as determined through a detailed hazard risk assessment. Other hazards that pose a "low" or "negligible" risk will continue to be evaluated during future updates to the Plan, but they may not be fully addressed until they are determined to be of high or moderate risk. This enables the participating jurisdictions to prioritize mitigation actions based on those hazards which are understood to present the greatest risk to lives and property.

The geographic scope (i.e., the planning area) for the Plan includes all of Wake County including all of its incorporated jurisdictions (see below) and unincorporated areas. **Table 1.1** indicates the participating jurisdictions.

TABLE 1.1: PARTICIPATING JURISDICTIONS IN THE WAKE COUNTY MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN

Wake County	
Apex	Morrisville
Cary	Raleigh
Fuquay-Varina	Rolesville

Garner	Wake Forest
Holly Springs	Wendell
Knightdale	Zebulon

1.4 AUTHORITY

The Wake County Multi-Jurisdictional Hazard Mitigation Plan has been developed in accordance with current state and federal rules and regulations governing local hazard mitigation plans and has been adopted by each participating jurisdiction in accordance with standard local procedures. Copies of the adoption resolutions for each participating jurisdiction are provided in Appendix A. The Plan shall be routinely monitored and revised to maintain compliance with the following provisions, rules, and legislation:

- Section 322, Mitigation Planning, of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as enacted by Section 104 of the Disaster Mitigation Act of 2000 (P.L. 106-390);
- FEMA's Final Rule published in the Federal Register, at 44 CFR Part 201 (201.6 for local mitigation planning requirements and 201.7 for Tribal planning requirements); and
- Flood Insurance Reform Act of 2004 (P.L. 108-264), Biggert-Waters Flood Insurance Reform Act of 2012 (P.L. 112-141) and the Homeowner Flood Insurance Affordability Act.

1.5 SUMMARY OF PLAN CONTENTS

The contents of this Plan are designed and organized to be as reader-friendly and functional as possible. While significant background information is included on the processes used and studies completed (i.e., risk assessment, capability assessment), this information is separated from the more meaningful planning outcomes or actions (i.e., mitigation strategy, mitigation action plan).

Section 2, ***Planning Process***, provides a complete narrative description of the process used to prepare the Plan. This includes the identification of participants on the planning team and describes how the public and other stakeholders were involved. It also includes a detailed summary for each of the key meetings held, along with any associated outcomes.

The ***Community Profile***, located in Section 3, provides a general overview of Wake County, including prevalent geographic, demographic, and economic characteristics. In addition, building characteristics and land use patterns are discussed. This baseline information provides a snapshot of the planning area and helps local officials recognize those social, environmental, and economic factors that ultimately play a role in determining the region’s vulnerability to hazards.

The Risk Assessment is presented in three sections: Section 4, ***Hazard Identification***; Section 5, ***Hazard Profiles***; and Section 6, ***Vulnerability Assessment***. Together, these sections serve to identify, analyze, and assess hazards that pose a threat to Wake County. The risk assessment also attempts to define any hazard risks that may uniquely or exclusively affect specific areas of Wake County.

The Risk Assessment begins by identifying hazards that threaten Wake County. Next, detailed profiles are established for each hazard, building on available historical data from past hazard occurrences, spatial extent, and probability of future occurrence. This section culminates in a hazard risk ranking based on conclusions regarding the frequency of occurrence, spatial extent, and potential impact highlighted in each of the hazard profiles. In the vulnerability assessment, FEMA's Hazus®MH loss estimation methodology is used in conjunction with GIS analysis to evaluate known hazard risks by their relative long-term cost in expected damages. In essence, the information generated through the risk assessment serves a critical function as the participating jurisdictions in Wake County seek to determine the most appropriate mitigation actions to pursue and implement—enabling them to prioritize and focus their efforts on those hazards of greatest concern and those structures or planning areas facing the greatest risk(s).

The ***Capability Assessment***, found in Section 7, provides a comprehensive examination of Wake County's capacity to implement meaningful mitigation strategies and identifies opportunities to increase and enhance that capacity. Specific capabilities addressed in this section include planning and regulatory capability, staff and organizational (administrative) capability, technical capability, fiscal capability, and political capability. Information was obtained through the use of a detailed survey questionnaire and an inventory and analysis of existing plans, ordinances, and relevant documents. The purpose of this assessment is to identify any existing gaps, weaknesses, or conflicts in programs or activities that may hinder mitigation efforts and to identify those activities that should be built upon in establishing a successful and sustainable local hazard mitigation program.

The *Risk Assessment*, and *Capability Assessment* collectively serve as a basis for determining the goals for the Wake County Multi-Jurisdictional Hazard Mitigation Plan, each contributing to the development, adoption, and implementation of a meaningful and manageable *Mitigation Strategy* that is based on accurate background information.

The ***Mitigation Strategy***, found in Section 8, consists of broad goal statements as well as an analysis of hazard mitigation techniques for the jurisdictions participating in the Wake County Multi-Jurisdictional Hazard Mitigation Plan to consider in reducing hazard vulnerabilities. The strategy provides the foundation for a detailed ***Mitigation Action Plan***, found in Section 9, which links specific mitigation actions for each jurisdiction to locally-assigned implementation mechanisms and target completion dates. Together, these sections are designed to make the Plan both strategic, through the identification of long-term goals, and functional, through the identification of immediate and short-term actions that will guide day-to-day decision-making and project implementation.

In addition to the identification and prioritization of possible mitigation projects, emphasis is placed on the use of program and policy alternatives to help make Wake County less vulnerable to the damaging forces of hazards while improving the economic, social, and environmental health of the community. The concept of multi-objective planning was emphasized throughout the planning process, particularly in identifying ways to link, where possible, hazard mitigation policies and programs with complimentary community goals related to disaster recovery, housing, economic development, recreational opportunities, transportation improvements, environmental quality, land development, and public health and safety.

Plan Maintenance, found in Section 10, includes the measures that the jurisdictions participating in the plan will take to ensure the Plan's continuous long-term implementation. The procedures also include the manner in which the Plan will be regularly evaluated and updated to remain a current and meaningful planning document.

Municipality-specific **Annexes** have been created to include specific information for each municipality. Topics covered in the annexes include community profile, risk assessment, vulnerability, and capability assessment information. The mitigation actions relevant for each particular municipal jurisdiction are also included in the Annex.

SECTION 2
PLANNING PROCESS

This section describes the planning process undertaken to develop the Wake County Multi-Jurisdictional Hazard Mitigation Plan. It consists of the following eight subsections:

- 2.1 Overview of Hazard Mitigation Planning
- 2.2 History of Hazard Mitigation Planning in Wake County
- 2.3 Preparing the 2014 Plan
- 2.4 East and West Wake Work Groups
- 2.5 The Wake County Coordinating Committee
- 2.6 Meetings and Workshops
- 2.7 Involving the Public
- 2.8 Documentation of Plan Progress

44 CFR Requirement
44 CFR Part 201.6(c)(1): The plan shall include documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process and how the public was involved.

2.1 OVERVIEW OF HAZARD MITIGATION PLANNING

Local hazard mitigation planning is the process of organizing community resources, identifying and assessing hazard risks, and determining how to best minimize or manage those risks. This process culminates in a hazard mitigation plan that identifies specific mitigation actions, each designed to achieve both short-term planning objectives and a long-term community vision.

To ensure the functionality of a hazard mitigation plan, responsibility is assigned for each proposed mitigation action to a specific individual, department, or agency along with a schedule or target completion date for its implementation. Mitigation actions for this plan are found in Section 9: *Mitigation Action Plan* and in each jurisdiction's Annex.

Plan maintenance procedures (see Section 10: *Plan Maintenance*) are established for the routine monitoring of implementation progress, as well as the evaluation and enhancement of the mitigation plan itself. These plan maintenance procedures ensure that the Plan remains a current, dynamic, and effective planning document over time that becomes integrated into the routine local decision making process.

Communities that participate in hazard mitigation planning have the potential to accomplish many benefits, including:

- saving lives and property,
- saving money,
- speeding recovery following disasters,

- reducing future vulnerability through wise development and post-disaster recovery and reconstruction,
- expediting the receipt of pre-disaster and post-disaster grant funding, and
- demonstrating a firm commitment to improving community health and safety.

Typically, communities that participate in mitigation planning are described as having the potential to produce long-term and recurring benefits by breaking the repetitive cycle of disaster loss. A core assumption of hazard mitigation is that the investments made before a hazard event will significantly reduce the demand for post-disaster assistance by lessening the need for emergency response, repair, recovery, and reconstruction. Furthermore, mitigation practices will enable local residents, businesses, and industries to re-establish themselves in the wake of a disaster, getting the community economy back on track sooner and with less interruption.

The benefits of mitigation planning go beyond solely reducing hazard vulnerability. Mitigation measures such as the acquisition or regulation of land in known hazard areas can help achieve multiple community goals, such as preserving open space, maintaining environmental health, and enhancing recreational opportunities. Thus, it is vitally important that any local mitigation planning process be integrated with other concurrent local planning efforts, and any proposed mitigation strategies must take into account other existing community goals or initiatives that will help complement or hinder their future implementation.

2.2 HISTORY OF HAZARD MITIGATION PLANNING IN WAKE COUNY

Each of the thirteen participating jurisdictions has a previously adopted hazard mitigation plan. The FEMA approval dates for each of these plans are listed below:

- *Town of Apex Hazard Mitigation Plan* (1/18/2011)
- *Town of Cary Hazard Mitigation Plan* (11/9/2010)
- *Town of Fuquay-Varina Hazard Mitigation Plan* (3/5/2010)
- *Town of Garner Hazard Mitigation Plan* (10/25/2011)
- *Town of Holly Springs Hazard Mitigation Plan* (4/11/2011)
- *Town of Knightdale Hazard Mitigation Plan* (10/28/2009)
- *Town of Morrisville Hazard Mitigation Plan* (12/22/2010)
- *City of Raleigh Hazard Mitigation Plan* (2/23/2010)
- *Town of Rolesville Hazard Mitigation Plan* (4/26/2011)
- *Wake County Hazard Mitigation Plan* (6/6/2010)
- *Town of Wake Forest Hazard Mitigation Plan* (8/27/2010)
- *Town of Wendell Hazard Mitigation Plan* (1/13/2010)
- *Town of Zebulon Hazard Mitigation Plan* (6/5/2012)

Each of the plans was developed using the multi-jurisdictional planning process recommended by the Federal Emergency Management Agency (FEMA). For this plan, all of the aforementioned jurisdictions have joined to form a multi-jurisdictional plan. The process of merging all of the above plans into this multi-jurisdictional plan is described in more detail below.

2.3 PREPARING THE 2014 PLAN

Hazard mitigation plans, are required to be updated every five years to remain eligible for federal mitigation funding. To simplify planning efforts, the jurisdictions in Wake County decided to join together to create the *Wake County Multi-Jurisdictional Hazard Mitigation Plan*. This allows resources to be shared amongst the participating jurisdictions and eases the administrative duties of all of the participants by combining the thirteen separate plans into one multi-jurisdictional plan.

To prepare the Plan, a team led by the consulting firm called Atkins was hired to provide professional mitigation planning services. The Atkins team was also supported by subconsultants from the Triangle J Council of Governments and AMEC. To meet planning requirements of the Community Rating System, the region ensured that the planning process was facilitated under the direction of a professional planner. Nathan Slaughter from Atkins served as the lead planner for this project and is a member of the American Institute of Certified Planners (AICP). Further, CRS planning requirements from section 510 of the 2013 Coordinator's Manual are addressed throughout this plan. The intent is to try to maximize the number of CRS points for those jurisdictions that currently participate in the CRS program (City of Raleigh) and those that may wish to join in the future.

Per the contractual scope of work, the consultant team followed the mitigation planning process recommended by FEMA (Publication Series 386 and Local Mitigation Plan Review Guide) and recommendations provided by North Carolina Division of Emergency Management (NCEM) mitigation planning staff[1]. The Local Mitigation Plan Review Tool, found in Appendix C, provides a detailed summary of FEMA's current minimum standards of acceptability for compliance with DMA 2000 and notes the location where each requirement is met within this Plan. These standards are based upon FEMA's Final Rule as published in the Federal Register in Part 201 of the Code of Federal Regulations (CFR). The planning team used FEMA's Local Mitigation Plan Review Guide (October 2011) for reference as they completed the Plan.

Although each participating jurisdiction had already developed a plan in the past, the combination of the thirteen plans into one multi-jurisdictional plan still required making some plan update revisions based on FEMA's Local Mitigation Plan Guide. Since all sections of the multi-jurisdictional plan are technically new, plan update requirements do not apply. However, since this is the first multi-jurisdictional plan that includes all of the jurisdictions in the County, key elements from the previous approved plans are referenced throughout the document (e.g., existing actions) and required a discussion of changes made. For example, all of the risk assessment elements needed to be updated to include most recent information. It was also necessary to formulate a single set of goals for the region, but they were based on previously determined goals (Section 8: *Mitigation Strategy*). The Capability Assessment section includes updated information for all of the participating jurisdictions and the Mitigation Action Plan provides implementation status updates for all of the actions identified in the previous plans.

The process used to prepare this Plan included twelve major steps that were completed over the course of approximately six months beginning in October 2013. Each of these planning steps (illustrated in **Figure 2.1**) resulted in critical work products and outcomes that collectively make up the Plan. Specific plan sections are further described in Section 1: *Introduction*.

[1] A copy of the negotiated contractual scope of work between Wake County and Atkins is available through Wake County upon request.

Over the past five years, each participating jurisdiction has been actively working to implement their existing plans. This is documented in the Mitigation Action Plan through the implementation status updates for each of the Mitigation Actions. The Capability Assessment also documents changes and improvements in the capabilities of each participating jurisdiction to implement the Mitigation Strategy.

FIGURE 2.1: MITIGATION PLANNING PROCESS FOR WAKE COUNTY

As is further detailed below, the planning process was conducted through Regional Work Groups comprised primarily of local government staff from each of the participating jurisdictions and a Coordinating Committee comprised of advisory stakeholders.

44 CFR Requirement
44 CFR Part 201.6(b)(2): The planning process shall include an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other non-profit interests to be involved in the planning process.

2.4 EAST AND WEST WAKE WORK GROUPS

In order to ensure adequate jurisdiction representation in the planning process, and to ensure that the consulting team was able to spend more constructive time with representatives from each jurisdiction, two Work Groups were formed for the development of this plan. The Work Groups consisted of representatives from each of the participating jurisdictions. The Work Groups coordinated on all aspects of plan preparation and provided valuable input to the process. In addition to regular meetings, Work Group members routinely communicated and were kept informed through an e-mail distribution list.

Specifically, the tasks assigned to the Work Group members included:

- participate in Work Group meetings and workshops
- provide best available data as required for the risk assessment portion of the Plan
- provide information that will help complete the Capability Assessment section of the Plan and provide copies of any mitigation or hazard-related documents for review and incorporation into the Plan
- support the development of the Mitigation Strategy, including the design and adoption of regional goal statements
- help design and propose appropriate mitigation actions for their department/agency for incorporation into the Mitigation Action Plan
- review and provide timely comments on all study findings and draft plan deliverables
- support the adoption of the *2014 Wake County Multi-Jurisdictional Hazard Mitigation Plan*

Figure 2.2 below provides a graphical representation of how the Work Groups were organized. The East Wake Work group included the jurisdictions of:

- Knightdale
- Rolesville
- Wake Forest
- Wendell
- Zebulon
- Raleigh
- Wake County

The West Wake Work Group included the jurisdictions of:

- Apex
- Cary
- Fuquay-Varina
- Garner
- Holly Springs
- Morrisville
- Raleigh
- Wake County

The City of Raleigh and Wake County participated on both Work Groups given the importance of these jurisdictions in helping to coordinate regional mitigation planning efforts.

FIGURE 2.2: WAKE COUNTY WORK GROUPS

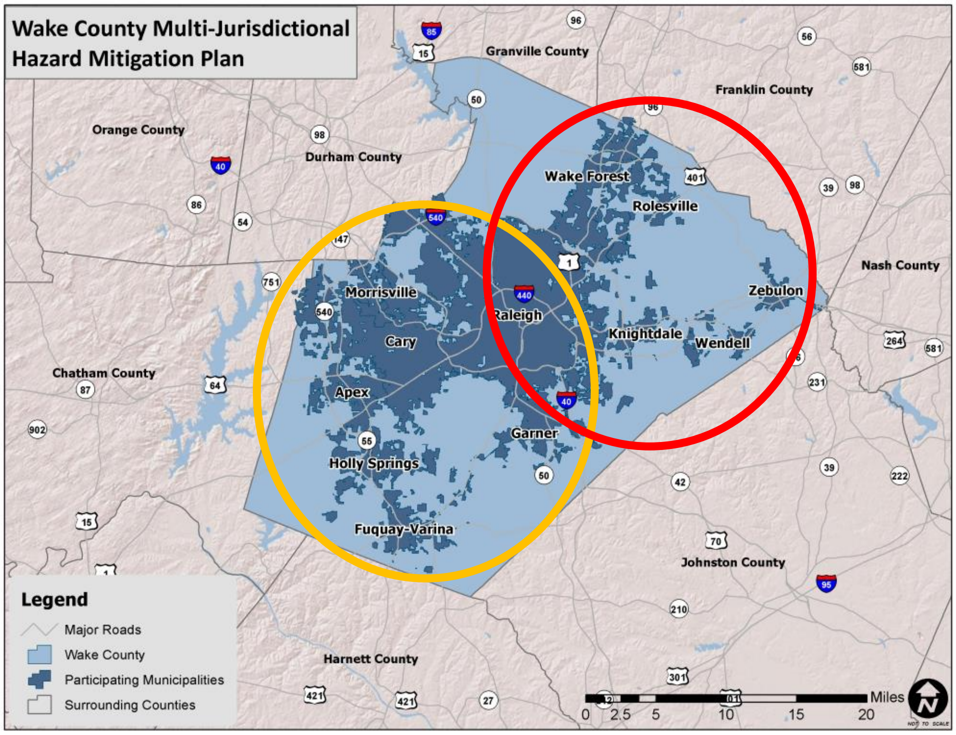


Table 2.1 lists the members of the Regional Work Groups who were responsible for participating in the development of the Plan. Committee members are listed in alphabetical order by last name.

TABLE 2.1: MEMBERS OF THE REGIONAL WORK GROUPS

NAME/TITLE	DEPARTMENT / JURISDICTION
East Wake Work Group	
Jeff Triezenberg / Senior Planner	Long Range Planning /Knightdale
Tim Guffey / Fire Chief	Fire Department / Knightdale
*Benjamin Brown / Stormwater Development Supervisor	Stormwater Department / Raleigh
*Derrick Remer / Emergency Manager	Emergency Management / Raleigh
Thomas Lloyd / Planning Director	Planning Department /Rolesville
Bryan Hicks / Town Manager	Administration / Rolesville
*Joshua Creighton / Emergency Management Director	Emergency Management / Wake County
*Sharon Peterson / Land Use Plan Administrator	Planning Department / Wake County
*Tim Maloney / Director Planning Development & Inspections	Planning Department /Wake County
Charlie Yokley / Senior Planner	Planning Department / Wake Forest
Agnes Wanman /Planner	Planning Department / Wake Forest

NAME/TITLE	DEPARTMENT / JURISDICTION
Patrick Reidy / Planner	Planning Department / Wendell
Alton Bryant / Director	Planning Department / Wendell
David Bergmark / Planner	Planning Department /Wendell
Julie Spriggs / Senior Planner	Planning Department / Zebulon
Robyn Snow / Public Works	Public Works / Zebulon
West Wake Work Group	
June Cowles / Senior Planner	Planning Department / Apex
Adam Stephenson / Senior Engineer	Engineering Services / Apex
Mary Beerman / Senior Planner	Planning Department / Cary
Charles Brown / Stormwater Program Analyst	Water Resources / Cary
Samantha Smith / Planner II	Planning Department / Fuquay-Varina
Michael Sorensen / Planning Director	Planning Department / Fuquay-Varina
Rodney Dickerson / Assistant Town Manager	Administration / Garner
Jaclyn Rametta / Stormwater Engineer	Engineering Department / Garner
David Bamford / Senior Planner	Planning Department / Garner
Daniel Weeks / Project Manager	Town Manager's Office / Holly Springs
Jeff Jones / Senior Planner	Planning Department / Holly Springs
TJ Cawley / Town Council Member	Holly Springs
Courtney Tanner / Senior Planner	Planning Department / Morrisville
Brad West / Planner	Planning Department / Morrisville
Chuck Queen / Risk and Safety Manager	Risk and Safety Management / Morrisville
*Benjamin Brown / Stormwater Development Supervisor	Stormwater Department / Raleigh
*Derrick Remer / Emergency Manager	Emergency Management / Raleigh
*Joshua Creighton / Emergency Management Director	Emergency Management / Wake County
*Sharon Peterson / Land Use Plan Administrator	Planning Department / Wake County
*Tim Maloney / Director Planning Development & Inspections	Planning Department /Wake County

*Participated on both East and West Wake Work Groups

2.4.1 Multi-Jurisdictional Participation

The Wake County Multi-Jurisdictional Hazard Mitigation Plan includes the county and twelve incorporated municipalities. To satisfy multi-jurisdictional participation requirements, each county and its participating jurisdictions were required to perform the following tasks:

- Participate in mitigation planning process;
- Identify completed mitigation projects, if applicable; and
- Develop and adopt (or update) their local Mitigation Action Plan.

Each jurisdiction that is participating in this plan has participated in the planning process and has developed a local Mitigation Action Plan unique to their jurisdiction. Each jurisdiction will adopt their Mitigation Action Plan separately. This provides the means for jurisdictions to monitor and update their Plan on a regular basis. Once FEMA has granted conditional approval of the Plan, each jurisdiction's local governing body will officially adopt the final Plan. Adoption resolutions will be included in Appendix A.

2.5 THE WAKE COUNTY COORDINATING COMMITTEE

With assistance from planning and social services staff of Triangle J Council of Governments, a Coordinating Committee was recruited and convened to serve as advisory stakeholders on the mitigation plan. The Coordinating Committee represents diverse community interests including business/industry, academia, social services, neighborhood and community groups, and the non-profit sector.

The Coordinating Committee engaged in two meetings in spring of 2014 to discuss and review tasks completed by the Regional Work Groups associated with the Plan. Project staff also set up a project Wikispaces website for providing draft Plan components for review to the Coordinating Committee, with the ability for them to provide input in three ways: 1) contact jurisdictional staff, whose contact information was provided; 2) leave comments on the Wiki pages; and 3) participate in Coordinating Committee meetings held as part of the Plan development process.

TABLE 2.2: MEMBERS OF THE WAKE COUNTY COORDINATING COMMITTEE

NAME	AFFILIATION
Randy Stark	Cary CERT
Louis Hufham	Citizen
Robert Greer	Citizen
Kyle Bolton	Cary CERT
Sue-Lynn Hinson	Cisco
Dave Wulff	Campbell University
Wendell Goodwin	Wake Tech Community College
Rob Denton	Wake Tech Community College
Steve Hardin	Wake Tech Community College
Tom Hegfle	Cary CERT
Lisa Booze	City of Raleigh
John Faison	CIR
Tolga Erkmen	Cary CERT
Lee Bullock	Wake Tech Community College
Leslie Richard	Cary CERT

2. 6 MEETINGS AND WORKSHOPS

The preparation of this Plan required a series of meetings and workshops for facilitating discussion, gaining consensus and initiating data collection efforts with local government staff, community officials, and other identified stakeholders. More importantly, the meetings and workshops prompted continuous input and feedback from relevant participants throughout the drafting stages of the Plan. The following is a listing of the key meetings and community workshops held during the development of the Plan update.[2] In many cases, routine discussions and additional meetings were held by local staff to accomplish planning tasks specific to their department or agency, such as the approval of specific mitigation actions for their department or agency to undertake and include in the Mitigation Action Plan.

November 21, 2013 - Project Kickoff Meeting

December 13, 2013 – West Wake Work Group Meeting

- November 21, 2013 – Project Kickoff Meeting (all stakeholders, advertised to public)
- December 12, 2013 – First East Wake Work Group Meeting
- December 13, 2013 – First West Wake Work Group Meeting
- January 28, 2014 – Second East Wake Work Group Meeting
- January 31, 2014 – Second West Wake Work Group Meeting
- April 1, 2014 – First Coordinating Committee Meeting

Detailed meeting summaries from each of the meetings listed above can be found in Appendix D.

2.7 INVOLVING THE PUBLIC

44 CFR Requirement
44 CFR Part 201.6(b)(1): The planning process shall include an opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.

An important component of the mitigation planning process involved public participation. Individual citizen and community-based input provides the entire planning team with a greater understanding of local concerns and increases the likelihood of successfully implementing mitigation actions by developing community "buy-in" from those directly affected by the decisions of public officials. As citizens become more involved in decisions that affect their safety, they are more likely to gain a greater appreciation of the hazards present in their community and take the steps necessary to reduce their impact. Public awareness is a key component of any community's overall mitigation strategy aimed at

[2] Copies of agendas, sign-in sheets, minutes, and handout materials for all meetings and workshops can be found in Appendix D.

making a home, neighborhood, school, business or entire city safer from the potential effects of hazards.

Public involvement in the development of the Wake County Multi-Jurisdictional Hazard Mitigation Plan sought using four methods: (1) all meetings in the development of the Plan were open to the public, and two meetings were advertised in local media; (2) public survey instruments were made available in hard copy and online in English and in Spanish; (3) the Coordinating Committee included multiple members of the general public; and 4) the draft Plan deliverables were made available on county and municipal websites and at government offices as well as on a project Wikispaces website along with contact information for providing input.

The general public was provided two opportunities to be involved in the development of the regional plan: (1) during the drafting stage of the Plan; and (2) upon completion of a final draft Plan, but prior to official Plan approval and adoption. In addition, a public participation survey (discussed in greater detail in Section 2.7.1) was made available during the planning process at various locations throughout the County and on participating jurisdiction websites.

A final open public meeting was held on December 30, 2014 at the City of Raleigh Municipal Building. The meeting, specifically held to discuss the hazard mitigation plan, was held more than two weeks prior to most plan adoption dates and was advertised by the participating jurisdictions on community websites and through community newsletters and ebulletins. The purpose of the meeting was to present the final plan and its findings and recommendations and so that the public could ask questions and submit any final comments for review, consideration, and potential modification of the plan. No additional public comments for the plan were provided at this meeting. The meeting agenda and sign-in sheet are included in Appendix D.

When the final Plan is officially adopted by the local governing bodies of each of the participating jurisdictions, the meetings of those local governing bodies will also be open to the public.

2.7.1 Public Survey

Triangle J Council of Governments, the Coordinating Committee, and the two Regional Work Groups were successful in getting citizens to provide input to the mitigation planning process through the use of the *Public Survey for Hazard Mitigation Planning*. The *Public Survey* was designed to capture data and information from residents of Wake County that might not be able to participate on the Coordinating Committee or participate through other means in the mitigation planning process.

The *Public Survey* was widely distributed in English (as a Word document, online, and in hard copy) and in Spanish (as a Word document and in hard copy)[3]. A total of 494 survey responses were received (5 translated from Spanish), which provided valuable input for the Coordinating Committee and Regional Work Groups to consider in the development of the Plan update. Selected survey results are presented below.

- Approximately 53 percent of survey respondents had been impacted by a disaster, mainly hurricanes (Fran—1996, Floyd—1999), winter storms (ice storm—2002, winter storm—2000, 2005, and 2014), and tornadoes (2011 and 2012).
- Respondents ranked Hurricane/Tropical Storm Wind as the highest threat to their neighborhoods (27 percent), followed by Severe Thunderstorm/High Wind (23 percent), Tornado (19 percent), and Severe Winter Storm/Freeze (13 percent).
- Approximately 43 percent of respondents have taken actions to make their homes more resistant to hazards and 87 percent are interested in making their homes more resistant to hazards.
- 74 percent of respondents do not know what office to contact regarding reducing their risks to hazards.
- Emergency Services and Prevention were ranked as the most important activities for communities to pursue in reducing risks.

A copy of the survey (in English and Spanish) is provided in Appendix B and a detailed summary of the survey results are provided in Appendix F.

2.8 DOCUMENTATION OF PLAN PROGRESS

Progress in hazard mitigation planning for the jurisdictions in Wake County is documented in this plan update. Since hazard mitigation planning efforts officially began in the participating jurisdictions with the development of the initial Hazard Mitigation Plans in the late 1990s and early 2000s, many mitigation actions have been completed and implemented in the participating jurisdictions. These actions will help reduce the overall risk to natural hazards for the people and property in Wake County. The actions that have been completed are documented in the Mitigation Action Plan found in Section 9.

[3] Details of the public survey can be found in Appendix B and Appendix F.

In addition, community capability continues to improve with the implementation of new plans, policies and programs that help to promote hazard mitigation at the local level. The current state of local capabilities for the participating jurisdictions is captured in Section 7: *Capability Assessment*. The participating jurisdictions continue to demonstrate their commitment to hazard mitigation and hazard mitigation planning and have proven this by developing the Coordinating Committee and Regional Work Groups to update the Plan and by continuing to involve the public in the hazard mitigation planning process.

SECTION 3
COMMUNITY PROFILE

This section of the Plan provides a general overview of Wake County and its participating municipalities. It consists of the following four subsections:

3.1 GEOGRAPHY AND THE ENVIRONMENT

Wake County is located in the eastern portion of the Piedmont of North Carolina. For the purposes of this plan, Wake County includes the Town of Apex, Town of Cary, Town of Fuquay-Varina, Town of Garner, Town of Holly Springs, Town of Knightdale, Town of Morrisville, City of Raleigh, Town of Rolesville, Town of Wake Forest, Town of Wendell, Town of Zebulon, and all unincorporated areas within the county. An orientation map is provided as **Figure 3.1**.

Wake County is best known as being home of the capital of North Carolina, Raleigh, and is home to a number of government agencies and functions. Many state agencies are located in Wake County as are many federal agencies.

Wake County is also known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Wake County is a popular tourist destination, especially for tourists from around the state who often come to learn about the state's history. In addition, Wake County and its municipalities are consistently ranked as some of the top places to live in the country which has led to significant population growth over the last 30 to 50 years.

The total land area of each of the participating jurisdictions is presented in **Table 3.1**.

TABLE 3.1: TOTAL LAND AREAS OF PARTICIPATING JURISDICTIONS

County	Total Land Area
WAKE COUNTY	**834 square miles**
Apex	15 square miles
Cary	54 square miles
Fuquay-Varina	12 square miles

County	Total Land Area
Garner	15 square miles
Holly Springs	15 square miles
Knightdale	6 square miles
Morrisville	8 square miles
Raleigh	142 square miles
Rolesville	4 square miles
Wake Forest	14 square miles
Wendell	5 square miles
Zebulon	4 square miles

Source: US Census Bureau

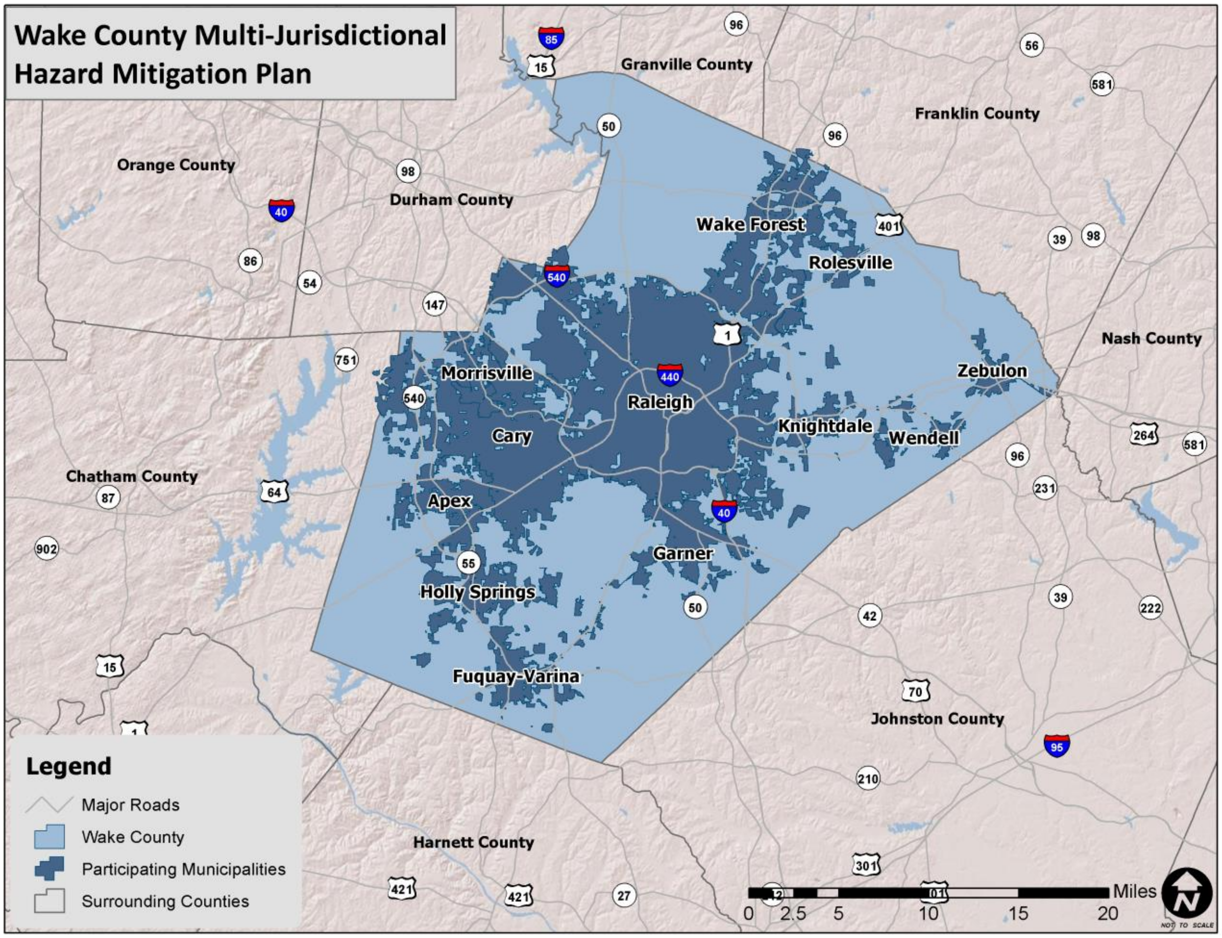
Wake County enjoys a moderate climate that is characterized by mild winters and hot, humid summers. In general, the spring months are marked by unpredictable weather and changes can occur rapidly with sunny skies yielding to severe thunderstorms in just a few hours. From March through May, temperatures have an average high in the low to mid 70s˚F with lows in the 50s˚F. Typically, the weather is milder by late March and warm by late April.

In the summer, afternoon showers and thunderstorms are common and average temperatures increase with afternoon highs reaching the 90s in July and August. These months are also the most common for rain in Wake County.

September through mid-November is typified by clear skies and cooler weather that alternates between warm days and cool nights. Highs and lows are usually similar to those experienced in the spring, with November days cooling off considerably.

Winter in Wake County is generally moderate but extremes do occur. High temperatures are usually in the lower 50s˚F and winter lows are usually at or just below freezing. Snow is most common during January and February.

FIGURE 3.1: WAKE COUNTY ORIENTATION MAP



3.2 POPULATION AND DEMOGRAPHICS

Raleigh is the largest participating municipal jurisdiction by area and it also has the largest population. Between 2000 and 2010, the majority of participating jurisdictions experienced population growth, sometimes doubling or tripling in size. Rolesville had the highest county growth rate at around 317%. Population counts from the US Census Bureau for 1990, 2000, and 2010 for each of the participating jurisdictions are presented in **Table 3.2**.

TABLE 3.2: POPULATION COUNTS FOR PARTICIPATING JURISDICTIONS

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
WAKE COUNTY	**423,380**	**627,846**	**900,993**	**43.51%**
Apex	4,968	20,212	37,476	85.41%
Cary	43,858	94,536	135,234	43.05%
Fuquay-Varina	4,562	7,898	17,937	127.11%
Garner	14,967	17,575	25,745	46.49%
Holly Springs	908	9,192	24,661	168.29%

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
Knightdale	1,884	5,958	11,401	91.36%
Morrisville	1,022	5,208	18,576	256.68%
Raleigh	207,951	276,093	403,892	46.29%
Rolesville	572	907	3,786	317.42%
Wake Forest	5,769	12,588	30,117	139.25%
Wendell	2,822	4,247	5,845	37.63%
Zebulon	3,173	4,046	4,433	9.57%

Note: The total population of Cary, Raleigh, and Wake Forest includes population residing in adjacent counties.
Source: US Census Bureau

Based on the 2010 Census, the median age of residents of in Wake County is 35.3. The racial characteristics of the participating jurisdictions are presented in **Table 3.3**. Generally, whites make up the majority of the population in the county accounting for over 65 percent of the population in overall. However, several jurisdictions have much higher minority populations than others including Garner, Knightdale, Morrisville, Raleigh, Wendell, and Zebulon.

TABLE 3.3: DEMOGRAPHICS OF PARTICIPATING JURISDICTIONS

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
WAKE COUNTY	**66.3%**	**20.7%**	**0.5%**	**12.5%**	**9.1%**
Apex	79.5%	7.6%	0.3%	12.6%	7.1%
Cary	73.1%	8.0%	0.4%	18.5%	7.2%
Fuquay-Varina	72.3%	19.7%	0.6%	7.4%	9.1%
Garner	57.8%	32.9%	0.5%	8.8%	9.3%
Holly Springs	79.8%	12.6%	0.4%	7.2%	5.8%
Knightdale	50.0%	38.3%	0.6%	11.1%	11.4%
Morrisville	54.0%	12.9%	0.4%	32.7%	5.5%
Raleigh	57.5%	29.3%	0.5%	12.7%	10.6%
Rolesville	74.1%	17.8%	0.4%	7.7%	6.1%
Wake Forest	77.3%	15.3%	0.4%	7.0%	5.1%
Wendell	58.1%	30.2%	0.8%	10.9%	10.5%
Zebulon	47.3%	38.6%	0.5%	13.6%	14.3%

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

3.3 HOUSING, INFRASTRUCTURE, AND LAND USE

3.3.1 Housing

According to the 2010 US Census, there were 371,836 housing units in Wake County, the majority of which are single family homes or mobile homes. Housing information for the thirteen participating jurisdictions is presented in **Table 3.4**. As shown in the table, there is a moderate range in the percentage of vacant housing across the jurisdictions.

TABLE 3.4: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Vacant Units, Percent (2010)	Median Home Value (2007-2011)
WAKE COUNTY	**258,953**	**371,836**	**7.0%**	**$230,400**
Apex	8,028	13,922	5.0%	$258,500
Cary	36,863	55,303	6.4%	$302,500
Fuquay-Varina	3,375	7,325	8.6%	$192,700
Garner	7,252	10,993	7.2%	$168,300
Holly Springs	3,642	8,658	5.9%	$236,700
Knightdale	2,352	4,723	10.5%	$170,900
Morrisville	3,210	8,357	8.6%	$266,600
Raleigh	120,699	176,124	7.5%	$208,000
Rolesville	384	1,341	7.8%	$246,200
Wake Forest	5,091	11,370	7.5%	$255,500
Wendell	1,785	2,430	6.6%	$132,600
Zebulon	1,661	1,862	11.1%	$110,400

Source: US Census Bureau

3.3.2 Infrastructure

Transportation

There are several major roadways that cross Wake County. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs that more or less encompass the city of Raleigh and provide access to many of the outlying municipalities. In conjunction with I-40, I-440 makes up the "Beltline" that encircles most of central Raleigh. Meanwhile, I-540/NC-540 is a partly completed loop that is outside the beltline that currently connects many of the northern and western municipalities. In addition to the Interstate, there are many major highways that traverse the county. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways in the county include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities

Electrical power in Wake County is provided by two entities and Duke Energy and Wake Electric Membership Corporation with Duke Energy providing service to a majority of the county. Water and sewer service is provided by two main entities as well: The City of Raleigh Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

Community Facilities

There are a number of public buildings and community facilities located throughout Wake County. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 81 fire stations, 38 police stations, and 158 public schools located within the study area.

Three major hospitals are located in Wake County: Rex Hospital, WakeMed, and Duke Raleigh. WakeMed also operates several satellite locations throughout the county.

Wake County is also home to several parks, including three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the jurisdictions, including the American Tobacco Trail which is a rails to trails project that is open to a wide variety of non-motorized uses.

3.3.3 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land. As shown in **Figure 3.1** above, there are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the study area consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

3.4 EMPLOYMENT AND INDUSTRY

The early modern economy Wake County was built around agriculture and government, as the state capital of Raleigh was established in 1793. Since that time, much of the growth and economic well-being of the county has been linked to the county's status as a hub of government. While the county's position as home to the state capital remains important, in recent decades, the county's economic focus has shifted towards the fields of information technology and health care. The Research Triangle Park, located between Raleigh and Durham, is home to more than 160 companies that employ more than 50,000 people.

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

SECTION 4
HAZARD IDENTIFICATION

This section describes how the planning team identified the hazards to be included this plan. It consists of the following five subsections:

- 4.1 Overview
- 4.2 Description of Full Range of Hazards
- 4.3 Disaster Declarations
- 4.4 Hazard Evaluation
- 4.5 Hazard Identification Results

44 CFR Requirement
44 CFR Part 201.6(c)(2)(i): The risk assessment shall include a description of the type, location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

4.1 OVERVIEW

Wake County is vulnerable to a wide range of natural and human-caused hazards that threaten life and property. Current FEMA regulations and guidance under the Disaster Mitigation Act of 2000 (DMA 2000) require, at a minimum, an evaluation of a full range of natural hazards. An evaluation of human-caused hazards (i.e., technological hazards, terrorism, etc.) is encouraged, though not required, for plan approval. Wake County has included a comprehensive assessment of both types of hazards.

Upon a review of the full range of natural hazards suggested under FEMA planning guidance, the participating jurisdictions in Wake County (Apex, Cary, Fuquay-Varina, Garner, Holly Springs, Knightdale, Morrisville, Raleigh, Rolesville, Wake Forest, Wendell, Zebulon) have identified a number of hazards that are to be addressed in their Multi-Jurisdictional Hazard Mitigation Plan. These hazards were identified through an extensive process that utilized input from the Wake County Hazard Mitigation Planning Committee members, research of past disaster declarations in the participating counties[1], and review of the North Carolina State Hazard Mitigation Plan (2010). Readily available information from reputable sources (such as federal and state agencies) was also evaluated to supplement information from these key sources.

Table 4.1 lists the full range of natural hazards initially identified for inclusion in the Plan and provides a brief description for each. This table includes 24 individual hazards. Some of these hazards are considered to be interrelated or cascading, but for preliminary hazard identification purposes these individual hazards are broken out separately.

Next, **Table 4.2** lists the disaster declarations in Wake County.

[1] A complete list of disaster declarations for Wake County can be found below in Section 4.3.

Next, **Table 4.3** documents the evaluation process used for determining which of the initially identified hazards are considered significant enough to warrant further evaluation in the risk assessment. For each hazard considered, the table indicates whether or not the hazard was identified as a significant hazard to be further assessed, how this determination was made, and why this determination was made. The table works to summarize not only those hazards that *were* identified (and why) but also those that *were not* identified (and why not). Hazard events not identified for inclusion at this time may be addressed during future evaluations and updates of the risk assessment if deemed necessary by the Hazard Mitigation Planning Committee during the plan update process.

Lastly, **Table 4.4** provides a summary of the hazard identification and evaluation process noting that 17 of the 24 initially identified hazards are considered significant enough for further evaluation through this Plan's risk assessment (marked with a "☑").

4.2 DESCRIPTION OF FULL RANGE OF HAZARDS

TABLE 4.1: DESCRIPTIONS OF THE FULL RANGE OF INITIALLY IDENTIFIED HAZARDS

Hazard	Description
ATMOSPHERIC HAZARDS	
Avalanche	A rapid fall or slide of a large mass of snow down a mountainside.
Drought	A prolonged period of less than normal precipitation such that the lack of water causes a serious hydrologic imbalance. Common effects of drought include crop failure, water supply shortages, and fish and wildlife mortality. High temperatures, high winds, and low humidity can worsen drought conditions and also make areas more susceptible to wildfire. Human demands and actions have the ability to hasten or mitigate drought-related impacts on local communities.
Hailstorm	Any storm that produces hailstones that fall to the ground; usually used when the amount or size of the hail is considered significant. Hail is formed when updrafts in thunderstorms carry raindrops into parts of the atmosphere where the temperatures are below freezing.
Heat Wave	A heat wave may occur when temperatures hover 10 degrees or more above the average high temperature for the region and last for several weeks. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground. Excessively dry and hot conditions can provoke dust storms and low visibility. A heat wave combined with a drought can be very dangerous and have severe economic consequences on a community.

Hurricane and Tropical Storm	Hurricanes and tropical storms are classified as cyclones and defined as any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and with a diameter averaging 10 to 30 miles across. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name, and is closely monitored by the National Hurricane Center. When sustained winds reach or exceed 74 miles per hour the storm is deemed a hurricane. The primary damaging forces associated with these storms are high-level sustained winds, heavy precipitation and tornadoes. Coastal areas are also vulnerable to the additional forces of storm surge, wind-driven waves and tidal flooding which can be more destructive than cyclone wind. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea and Gulf of Mexico during the official Atlantic hurricane season, which extends from June through November.
Lightning	Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a “bolt” when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes, but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes thunder. On average, 73 people are killed each year by lightning strikes in the United States.
Nor’easter	Similar to hurricanes, nor’easters are ocean storms capable of causing substantial damage to coastal areas in the Eastern United States due to their associated strong winds and heavy surf. Nor'easters are named for the winds that blow in from the northeast and drive the storm up the East Coast along the Gulf Stream, a band of warm water that lies off the Atlantic coast. They are caused by the interaction of the jet stream with horizontal temperature gradients and generally occur during the fall and winter months when moisture and cold air are plentiful. Nor’easters are known for dumping heavy amounts of rain and snow, producing hurricane-force winds, and creating high surf that causes severe beach erosion and coastal flooding.
Tornado	A tornado is a violently rotating column of air that has contact with the ground and is often visible as a funnel cloud. Its vortex rotates cyclonically with wind speeds ranging from as low as 40 mph to as high as 300 mph. Tornadoes are most often generated by thunderstorm activity when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The destruction caused by tornadoes ranges from light to catastrophic depending on the intensity, size and duration of the storm.
Severe Thunderstorm	Thunderstorms are caused by air masses of varying temperatures meeting in the atmosphere. Rapidly rising warm moist air fuels the formation of thunderstorms. Thunderstorms may occur singularly, in lines, or in clusters. They can move through an area very quickly or linger for several hours. Thunderstorms may result in hail, tornadoes, or straight-line winds. Windstorms pose a threat to lives, property, and vital utilities primarily due to the effects of flying debris and can down trees and power lines.

Winter Storm and Freeze	Winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. Blizzards, the most dangerous of all winter storms, combine low temperatures, heavy snowfall, and winds of at least 35 miles per hour, reducing visibility to only a few yards. Ice storms occur when moisture falls and freezes immediately upon impact on trees, power lines, communication towers, structures, roads and other hard surfaces. Winter storms and ice storms can down trees, cause widespread power outages, damage property, and cause fatalities and injuries to human life.
GEOLOGIC HAZARDS	
Earthquake	A sudden, rapid shaking of the Earth caused by the breaking and shifting of rock beneath the surface. This movement forces the gradual building and accumulation of energy. Eventually, strain becomes so great that the energy is abruptly released, causing the shaking at the earth's surface which we know as an earthquake. Roughly 90 percent of all earthquakes occur at the boundaries where plates meet, although it is possible for earthquakes to occur entirely within plates. Earthquakes can affect hundreds of thousands of square miles; cause damage to property measured in the tens of billions of dollars; result in loss of life and injury to hundreds of thousands of persons; and disrupt the social and economic functioning of the affected area.
Expansive Soils	Soils that will exhibit some degree of volume change with variations in moisture conditions. The most important properties affecting degree of volume change in a soil are clay mineralogy and the aqueous environment. Expansive soils will exhibit expansion caused by the intake of water and, conversely, will exhibit contraction when moisture is removed by drying. Generally speaking, they often appear sticky when wet, and are characterized by surface cracks when dry. Expansive soils become a problem when structures are built upon them without taking proper design precautions into account with regard to soil type. Cracking in walls and floors can be minor, or can be severe enough for the home to be structurally unsafe.
Landslide	The movements of a mass of rock, debris, or earth down a slope when the force of gravity pulling down the slope exceeds the strength of the earth materials that comprise to hold it in place. Slopes greater than 10 degrees are more likely to slide, as are slopes where the height from the top of the slope to its toe is greater than 40 feet. Slopes are also more likely to fail if vegetative cover is low and/or soil water content is high.
Land Subsidence	The gradual settling or sudden sinking of the Earth's surface due to the subsurface movement of earth materials. Causes of land subsidence include groundwater pumpage, aquifer system compaction, drainage of organic soils, underground mining, hydrocompaction, natural compaction, sinkholes, and thawing permafrost.
Tsunami	A series of waves generated by an undersea disturbance such as an earthquake. The speed of a tsunami traveling away from its source can range from up to 500 miles per hour in deep water to approximately 20 to 30 miles per hour in shallower areas near coastlines. Tsunamis differ from regular ocean waves in that their currents travel from the water surface all the way down to the sea floor. Wave amplitudes in deep water are typically less than one meter; they are often barely detectable to the human eye. However, as they approach shore, they slow in shallower water, basically causing the waves from behind to effectively "pile up", and wave heights to increase dramatically. As opposed to typical waves which crash at the shoreline, tsunamis bring with them a continuously flowing 'wall of water' with the potential to cause devastating damage in coastal areas located immediately along the shore.

Volcano	A mountain that opens downward to a reservoir of molten rock below the surface of the earth. While most mountains are created by forces pushing up the earth from below, volcanoes are different in that they are built up over time by an accumulation of their own eruptive products: lava, ash flows, and airborne ash and dust. Volcanoes erupt when pressure from gases and the molten rock beneath becomes strong enough to cause an explosion.
HYDROLOGIC HAZARDS	
Dam and Levee Failure	Dam failure is the collapse, breach, or other failure of a dam structure resulting in downstream flooding. In the event of a dam failure, the energy of the water stored behind even a small dam is capable of causing loss of life and severe property damage if development exists downstream of the dam. Dam failure can result from natural events, human-induced events, or a combination of the two. The most common cause of dam failure is prolonged rainfall that produces flooding. Failures due to other natural events such as hurricanes, earthquakes or landslides are significant because there is generally little or no advance warning.
Erosion	Erosion is the gradual breakdown and movement of land due to both physical and chemical processes of water, wind, and general meteorological conditions. Natural, or geologic, erosion has occurred since the Earth's formation and continues at a very slow and uniform rate each year.
Flood	The accumulation of water within a water body which results in the overflow of excess water onto adjacent lands, usually floodplains. The floodplain is the land adjoining the channel of a river, stream ocean, lake or other watercourse or water body that is susceptible to flooding. Most floods fall into the following three categories: riverine flooding, coastal flooding, or shallow flooding (where shallow flooding refers to sheet flow, ponding and urban drainage).
Storm Surge	A storm surge is a large dome of water often 50 to 100 miles wide and rising anywhere from four to five feet in a Category 1 hurricane up to more than 30 feet in a Category 5 storm. Storm surge heights and associated waves are also dependent upon the shape of the offshore continental shelf (narrow or wide) and the depth of the ocean bottom (bathymetry). A narrow shelf, or one that drops steeply from the shoreline and subsequently produces deep water close to the shoreline, tends to produce a lower surge but higher and more powerful storm waves. Storm surge arrives ahead of a storm's actual landfall and the more intense the hurricane is, the sooner the surge arrives. Storm surge can be devastating to coastal regions, causing severe beach erosion and property damage along the immediate coast. Further, water rise caused by storm surge can be very rapid, posing a serious threat to those who have not yet evacuated flood-prone areas.

OTHER HAZARDS	
Hazardous Materials Incident	Hazardous material (HAZMAT) incidents can apply to fixed facilities as well as mobile, transportation-related accidents in the air, by rail, on the nation's highways and on the water. HAZMAT incidents consist of solid, liquid and/or gaseous contaminants that are released from fixed or mobile containers, whether by accident or by design as with an intentional terrorist attack. A HAZMAT incident can last hours to days, while some chemicals can be corrosive or otherwise damaging over longer periods of time. In addition to the primary release, explosions and/or fires can result from a release, and contaminants can be extended beyond the initial area by persons, vehicles, water, wind and possibly wildlife as well.
Terror Threat	Terrorism is defined by FEMA as, "the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion, or ransom." Terrorist acts may include assassinations, kidnappings, hijackings, bomb scares and bombings, cyber attacks (computer-based), and the use of chemical, biological, nuclear and radiological weapons.
Wildfire	An uncontrolled fire burning in an area of vegetative fuels such as grasslands, brush, or woodlands. Heavier fuels with high continuity, steep slopes, high temperatures, low humidity, low rainfall, and high winds all work to increase risk for people and property located within wildfire hazard areas or along the urban/wildland interface. Wildfires are part of the natural management of forest ecosystems, but most are caused by human factors. Over 80 percent of forest fires are started by negligent human behavior such as smoking in wooded areas or improperly extinguishing campfires. The second most common cause for wildfire is lightning.
Nuclear Accident	A nuclear and radiation accident is defined by the International Atomic Energy Agency as "an event that has led to significant consequences to people, the environment or the facility. Often, this type of incident results from damage to the reactor core of a nuclear power plant which can release radioactivity into the environment. The degree of exposure from nuclear accidents has varied from serious to catastrophic.

4.3 DISASTER DECLARATIONS

Disaster declarations provide initial insight into the hazards that may impact the Wake County planning area. Since 1968, thirteen presidential disaster declarations have been reported in Wake County. This includes five storms related to severe winter weather, three events related to severe storms, tornadoes, and flooding, three hurricanes or tropical storms, and two drought related events.

TABLE 4.2: WAKE COUNTY DISASTER DECLARATIONS

Year	Disaster Number	Description
1968	234	Severe Ice Storm
1977	3033	Drought & Freezing
1977	3049	Drought

Year	Disaster Number	Description
1988	818	Severe Storms & Tornadoes
1993	3110	Severe Snowfall & Winter Storm
1996	1087	Blizzard Of 96
1996	1134	Hurricane Fran
1998	1211	Severe Storms Tornadoes, And Flooding
1999	1292	Hurricane Floyd Major Disaster Declarations
2000	1312	Severe Winter Storm
2002	1448	Severe Ice Storm
2003	1490	Hurricane Isabel
2011	1969	Severe Storms, Tornadoes, And Flooding

4.4 HAZARD EVALUATION

TABLE 4.3: DOCUMENTATION OF THE HAZARD EVALUATION PROCESS

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (Yes or No)	How was this determination made?	Why was this determination made?
ATMOSPHERIC HAZARDS			
Avalanche	NO	• Review of US Forest Service National Avalanche Center web site • Review of the NC State Hazard Mitigation Plan • Review of FEMA's Multi-Hazard Identification and Risk Assessment • Review of previous hazard mitigation plans in Wake County	• There is no risk of avalanche events in North Carolina. The United States avalanche hazard is limited to mountainous western states including Alaska, as well as some areas of low risk in New England. • Avalanche hazard was removed from the North Carolina State Hazard Mitigation Plan after determining the mountain elevation in Western North Carolina did have enough snow not produce this hazard. • Avalanche is not included in any of the previous Wake County or municipal mitigation plans.
Drought	YES	• Review of the NC State Hazard Mitigation Plan • Review of the North Carolina Drought Monitor website • Review of previous hazard mitigation plans in Wake County	• There are reports of drought conditions in each of the last fourteen years in Wake County, according to the North Carolina Drought Monitor. • Droughts are discussed in NC State Hazard Mitigation Plan as a lesser hazard. • The NC State Hazard Mitigation Plan lists drought as a hazard for the Piedmont 4 Region which includes Wake County. • Drought is included in 12 of 13 previous hazard mitigation plans.

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (Yes or No)	How was this determination made?	Why was this determination made?
Hailstorm	YES	• Review of NC State Hazard Mitigation Plan • Review of FEMA's Multi-Hazard Identification and Risk Assessment • Review of NOAA NCDC Storm Events Database • Review of previous hazard mitigation plans in Wake County	• Hailstorm events are discussed in the state plan under the Severe Thunderstorm hazard. • NCDC reports 261 hailstorm events (3/4 inch size hail to 4 inches) for Wake County between 1966 and 2013. For these events there were $9,000 (2013 dollars) in property damages. • Although hail is not addressed as an individual hazard in any of the previous hazard mitigation plans, it is addressed as a sub-item under thunderstorms in many of the plans. Given the frequency of the event, individual analysis is warranted.
Heat Wave	YES	• Review of NOAA NCDC Storm Events Database • Review of the North Carolina State Hazard Mitigation Plan • Review of previous hazard mitigation plans in Wake County	• NCDC reports 2 extreme heat events for Wake County. • The NC State Hazard Mitigation Plan includes Heat Wave as a top hazard for the Piedmont 4 Region which includes Wake County. • The NC State Hazard Mitigation Plan reports the central portion of the state as having a moderate vulnerability. • Heat wave was mentioned in two of the 13 previous hazard mitigation plans in tandem with the drought hazard.

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (Yes or No)	How was this determination made?	Why was this determination made?
Hurricane and Tropical Storm	YES	• Review of NC State Hazard Mitigation Plan • Analysis of NOAA historical tropical cyclone tracks and National Hurricane Center Website • Review of NOAA NCDC Storm Events Database • Review of historical presidential disaster declarations • FEMA Hazus-MH storm return periods • Review of previous hazard mitigation plans in Wake County	• Hurricane and tropical storm events are discussed in the state plan and are listed as a top hazard in the Piedmont 4 Region which includes Wake County • NOAA historical records indicate 8 hurricanes, 55 tropical storms and 24 tropical depressions have come within 75 miles of Wake County since 1850. • Three out of thirteen disaster declarations in Wake County are directly related to hurricane and tropical storm events. • Hurricane and tropical storm hazard was addressed in all of the previous plans.
Lightning	YES	• Review of NC State Hazard Mitigation Plan • Review of FEMA's Multi-Hazard Identification and Risk Assessment • Review of NOAA NCDC Storm Events Database, NOAA lightning statistics • Review of previous hazard mitigation plans in Wake County	• Lightning events are discussed in the state plan as part of the severe thunderstorm hazard. • NCDC reports 34 lightning events for Wake County since 1950. These events have resulted in a recorded 2 deaths and $3.3 million (2013 dollars) in property damage. • Although lightning is not addressed as an individual hazard in any of the previous hazard mitigation plans, it is addressed under thunderstorms in several plans. Given the damage and reported deaths, individual analysis is warranted.

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (Yes or No)	How was this determination made?	Why was this determination made?
Nor'easter	NO	• Review of NC State Hazard Mitigation Plan • Review of NOAA NCDC Storm Events Database • Review of previous hazard mitigation plans in Wake County	• Nor'easters are discussed in the state plan. The Piedmont Region, which includes Wake County, has the lowest vulnerability in the state. • NCDC does not report any nor'easter activity for Wake County. However, nor'easters may have affected the area as severe winter storms. In this case, the activity would be reported under winter storm events. • Nor'easters were not identified in any of the previous hazard mitigation plans.
Tornado	YES	• Review of NC State Hazard Mitigation Plan • Review of FEMA's Multi-Hazard Identification and Risk Assessment • Review of NOAA NCDC Storm Events Database • Review of previous hazard mitigation plans in Wake County	• Tornado events are discussed in the NC State Hazard Mitigation Plan. • NCDC reports 33 tornado events in Wake County since 1956. These events have resulted in 7 recorded deaths and have caused 213 injuries and $706.3 million (2013 dollars) in property damage with the most severe being an F4. • Tornado events were addressed in all of the previous plans.
Severe Thunderstorm	YES	• Review of NC State Hazard Mitigation Plan • Review of FEMA's Multi-Hazard Identification and Risk Assessment • Review of NOAA NCDC Storm Events Database • Review of previous hazard mitigation plans in Wake County	• Severe thunderstorm events are discussed in the NC State Hazard Mitigation Plan. The Piedmont 4 Region, including Wake County, has a moderately high vulnerability. • NCDC reports 351 thunderstorm wind events in Wake County between since 1950. These events have resulted in 1 death, 6 injuries and $1.2 million (2013 dollars) in property damage. • Severe thunderstorm events were addressed in all of the previous plans.

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (Yes or No)	How was this determination made?	Why was this determination made?
Winter Storm and Freeze	YES	• Review of NC State Hazard Mitigation Plan • Review of FEMA's Multi-Hazard Identification and Risk Assessment • Review of historical presidential disaster declarations. • Review of NOAA NCDC Storm Events Database • Review of previous hazard mitigation plans in Wake County	• Severe winter storms, including snow storms and ice storms, are discussed in the state plan. They are listed as a hazard in the Piedmont 4 Region which includes Wake County. • NCDC reports that Wake County has been affected by 28 snow and ice events since 1993. These events resulted in over $900,000 (2013dollars) in damages but did not cause any deaths or injuries in Wake County. • Five of the region's thirteen disaster declarations were directly related to winter storm events. • Winter storm events were addressed in all of the previous plans.

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (Yes or No)	How was this determination made?	Why was this determination made?
GEOLOGIC HAZARDS			
Earthquake	YES	• Review of NC State Hazard Mitigation Plan • Review of previous hazard mitigation plans in Wake County USGS Earthquake Hazards Program web site • Review of the National Geophysical Data Center • Review of FEMA's Multi-Hazard Identification and Risk Assessment	• Earthquake events are discussed in the state plan and all of the participating jurisdictions in Wake County are considered to be at low to moderate risk to an earthquake event. • Twelve of thirteen previous plans address earthquake. • Earthquakes have occurred in and around the State of North Carolina in the past. The state is affected by the Charleston and the New Madrid (near Missouri) Fault lines which have generated a magnitude 8.0 earthquake in the last 200 years. • 13 events are known to have occurred in the region according to the National Geophysical Data Center. The greatest MMI reported was an 8. • According to USGS seismic hazard maps, the peak ground acceleration (PGA) with a 10% probability of exceedance in 50 years for Wake County is approximately 2%g. Although FEMA recommends that earthquakes be further evaluated for mitigation purposes in areas with a PGA of 3%g or more, this is close enough to warrant consideration given the history of some earthquake activity.

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (Yes or No)	How was this determination made?	Why was this determination made?
Expansive Soils	NO	• Review of NC State Hazard Mitigation Plan • Review of FEMA's Multi-Hazard Identification and Risk Assessment • Review of USDA Soil Conservation Service's Soil Survey • Review of previous hazard mitigation plans in Wake County	• Expansive soils are identified in the state plan; however Piedmont 4 Region does not identify expansive soils as a top hazard. • Although Wake County is located in an area that has some clay swelling potential, it is not great enough to consider evaluating in terms of mitigation. • Only one of the previous hazard mitigation plans identify expansive soils as a potential hazard.
Landslide	YES	• Review of NC State Hazard Mitigation Plan • Review of USGS Landslide Incidence and Susceptibility Hazard Map • Review of the North Carolina Geological Survey database of historic landslides • Review of previous hazard mitigation plans in Wake County	• Landslide/debris flow events are discussed in the state plan, and ranked as a hazard in the Piedmont 4 Region which includes Wake County. • USGS landslide hazard maps indicate that a moderate incidence rate is found in at least part of the county. • Data provided by NCGS indicate 11 recorded landslide events in the Wake County. There were no recorded deaths or injuries but some reports of damage to houses and roads. • All but 4 of the previous hazard mitigation plans address landslides.
Land Subsidence	NO	• Review of NC State Hazard Mitigation Plan • Review of previous hazard mitigation plans in Wake County	• The state plan delineates certain areas that are susceptible to land subsidence hazards in North Carolina; however none of these areas are located in Wake County. • The plan identifies Wake County as having scored low to moderate for the land subsidence hazard. • Only one of the previous hazard mitigation plans identifies land subsidence as a potential hazard.

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (Yes or No)	How was this determination made?	Why was this determination made?
Tsunami	NO	• Review of NC State Hazard Mitigation Plan • Review of previous hazard mitigation plans in Wake County • Review of FEMA's Multi-Hazard Identification and Risk Assessment • Review of FEMA "How-to" mitigation planning guidance (Publication 386-2, "Understanding Your Risks – Identifying Hazards and Estimating Losses).	• Tsunamis are discussed in the state plan and described as a "greater" hazard for the state. However, the Piedmont Region scored a zero for tsunami hazard risk. • Although several of the previous plans mention the tsunami hazard, it is not fully addressed in any of the plans as it is identified as being highly unlikely to occur. • No record exists of a catastrophic Atlantic basin tsunami impacting the mid-Atlantic coast of the United States. • Tsunami inundation zone maps are not available for communities located along the U.S. East Coast. • FEMA mitigation planning guidance suggests that locations along the U.S. East Coast have a relatively low tsunami risk and need not conduct a tsunami risk assessment at this time.
Volcano	NO	• Review of NC State Hazard Mitigation Plan • Review of USGS Volcano Hazards Program web site	• There are no active volcanoes in North Carolina. • There has not been a volcanic eruption in North Carolina in over 1 million years. • No volcanoes are located near Wake County.

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (Yes or No)	How was this determination made?	Why was this determination made?
HYDROLOGIC HAZARDS			
Dam and Levee Failure	YES	• Review of NC State Hazard Mitigation Plan • Review of North Carolina Division of Land Management web site • Review of U.S. Army Corps of Engineers National Inventory of Dams database • Review of previous hazard mitigation plans in Wake County	• Dam failure is discussed in the state plan as a hazard of concern for Wake County. It is a hazard for Piedmont Region 4 which Wake County. However, the region does not have the greatest vulnerability in the state. • Of the 401 dams reported on the National Inventory of Dams, 144 are high hazard (36%), (High hazard is defined as "where failure or mis-operation will probably cause loss of human life.") • 12 of 13 of the previous hazard mitigation plans address dam failure.
Erosion	YES	• Review of NC State Hazard Mitigation Plan • Review of previous hazard mitigation plans in Wake County	• Erosion is addressed directly in few of the previous mitigation plans. However, it is considered a cascading hazard that results from other hazards in many plans. • Riverine erosion has the potential to affect Wake County since several rivers/streams run through the county.

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (Yes or No)	How was this determination made?	Why was this determination made?
Flood	YES	• Review of NC State Hazard Mitigation Plan • Review of historical disaster declarations • Review of NOAA NCDC Storm Events Database • Review of FEMA's NFIP Community Status Book and Community Rating System (CRS) • Review of previous hazard mitigation plans in Wake County	• The flood hazard is thoroughly discussed in the state plan. • Three out of thirteen Presidential Disaster Declarations were flood-related and an additional three were hurricane or tropical storm-related which caused flooding issues. • NCDC reports that Wake County has been affected by 100 flood events since 1993. These events in total caused an estimated $10.6 million (2013 dollars) in property damages. • Roughly 10% of Wake County is located in an identified floodplain (100 or 500 year). • All jurisdictions participate in the NFIP. • All of the previous plans address flood hazard.
Storm Surge	NO	• Review of NC State Hazard Mitigation Plan • Review of previous hazard mitigation plans in Wake County • Review of NOAA NCDC Storm Events Database	• Storm surge is discussed in the state plan under the hurricane hazard and indicates that the Piedmont 4 Region has zero vulnerability to storm surge. • None of the previous hazard mitigation plans address storm surge. • No historical events were reported by NCDC • Given the inland location of the Piedmont 4 Region, storm surge would not affect the area.
OTHER HAZARDS			
Hazardous Materials Incident	YES	• Review of previous hazard mitigation plans in Wake County • Review of hazardous materials spills in the county	• Although few of the previous hazard mitigation plans include hazardous materials incidents, several identify man-made hazards. • There is a moderate history of hazardous materials incidents in Wake County

Natural Hazards Considered	Was this hazard identified as a significant hazard to be addressed in the plan at this time? (Yes or No)	How was this determination made?	Why was this determination made?
Terror Threat	YES	• Review of previous hazard mitigation plans in Wake County • Review of local official knowledge	• Some of the previous hazard mitigation plans for the region included terrorism threat as a hazard under human caused or man-made hazards. • There are several high profiles targets in the area that caused the planning committee to determine that the hazard should be evaluated further.
Wildfire	YES	• Review of NC State Hazard Mitigation Plan • Review of previous hazard mitigation plans in Wake County • Review of Southern Wildfire Risk Assessment (SWRA) Data • Review of the NC Division of Forest Resources website	• Wildfires are discussed in the state plan as a "greater" hazard of concern. • Most of the previous plans addressed wildfire. • The state plan lists wildfire as a hazard in the Piedmont 4 Region. • A review of SWRA data indicates that there are some areas of elevated concern in Wake County. • According to the North Carolina Division of Forest Resources, Wake County experiences an average of 16 fires each year which burn a combined 98 acres. • Wildfire hazard risks will increase as low-density development along the urban/wildland interface increases.
Nuclear Accident	YES	• Review of NC State Hazard Mitigation Plan • Review of previous hazard mitigation plans in Wake County • Review of IAEA data on the location of nuclear reactors	• Although nuclear accidents are not specifically identified in the State Hazard Mitigation Plan, the location of nuclear reactors in the county is well known. • Although most of the previous plans did not address a nuclear accident, this is not uncommon given the natural hazard focus of previous mitigation plans. • A nuclear accident is unlikely to occur, but could cause severe damage in the event of a major incident.

4.5 HAZARD IDENTIFICATION RESULTS

TABLE 4.4: SUMMARY RESULTS OF THE HAZARD IDENTIFICATION AND EVALUATION PROCESS

ATMOSPHERIC HAZARDS	GEOLOGIC HAZARDS
☐ Avalanche	☑ Earthquake
☑ Drought	☐ Expansive Soils
☑ Hailstorm	☑ Landslide
☑ Heat Wave	☐ Land Subsidence
☑ Hurricane and Tropical Storm	☐ Tsunami
☑ Lightning	☐ Volcano
☐ Nor'easter	**HYDROLOGIC HAZARDS**
☑ Tornado	☑ Dam and Levee Failure
☑ Severe Thunderstorm	☑ Erosion
☑ Winter Storm and Freeze	☑ Flood
	☐ Storm Surge
	OTHER HAZARDS
	☑ Hazardous Materials Incident
	☑ Wildfire
	☑ Nuclear Accident
	☑ Terror Threat

☑ = Hazard considered significant enough for further evaluation in the Wake County hazard risk assessment.

SECTION 5
HAZARD PROFILES

This section includes detailed hazard profiles for each of the hazards identified in the previous section (*Hazard Identification*) as significant enough for further evaluation in the Wake County Multi-Jurisdictional Hazard Mitigation Plan. It contains the following subsections:

44 CFR Requirement
44 CFR Part 201.6(c)(2)(i): The risk assessment shall include a description of the type, location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events

5.1 OVERVIEW

This section includes detailed hazard profiles for each of the hazards identified in the previous section (*Hazard Identification*) as significant enough for further evaluation in the Wake County hazard risk assessment by creating a hazard profile. Each hazard profile includes a general description of the hazard, its location and extent, notable historical occurrences, the probability of future occurrences, and a brief consequence analysis that outlines potential impacts on people, the built environment, the economy, and the natural environment. Each profile also includes specific items noted by members of the Wake County Regional Work Groups as it relates to unique historical or anecdotal hazard information for the county and its municipalities.

The following hazards were identified:

- **Atmospheric**
  - Drought
  - Extreme Heat
  - Hailstorm
  - Hurricane and Tropical Storm

  - Lightning
  - Severe Thunderstorm (including straight-line winds)
  - Tornado
  - Winter Storm and Freeze
- **Geologic**
  - Earthquake
  - Landslide
- **Hydrologic**
  - Dam and Levee Failure
  - Erosion
  - Flood
- **Other**
  - Hazardous Materials Incident
  - Wildfire
  - Nuclear Accident
  - Terror Threat

5.2 STUDY AREA

Wake County includes twelve municipalities. **Table 5.1** provides a summary table of the participating jurisdictions within the county. In addition, **Figure 5.1** provides a base map, for reference, of Wake County and its incorporated municipalities.

TABLE 5.1: PARTICIPATING JURISDICTIONS IN THE WAKE COUNTY MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN

Wake County	
Apex	Morrisville
Cary	Raleigh
Fuquay-Varina	Rolesville
Garner	Wake Forest
Holly Springs	Wendell
Knightdale	Zebulon

FIGURE 5.1: WAKE COUNTY BASE MAP

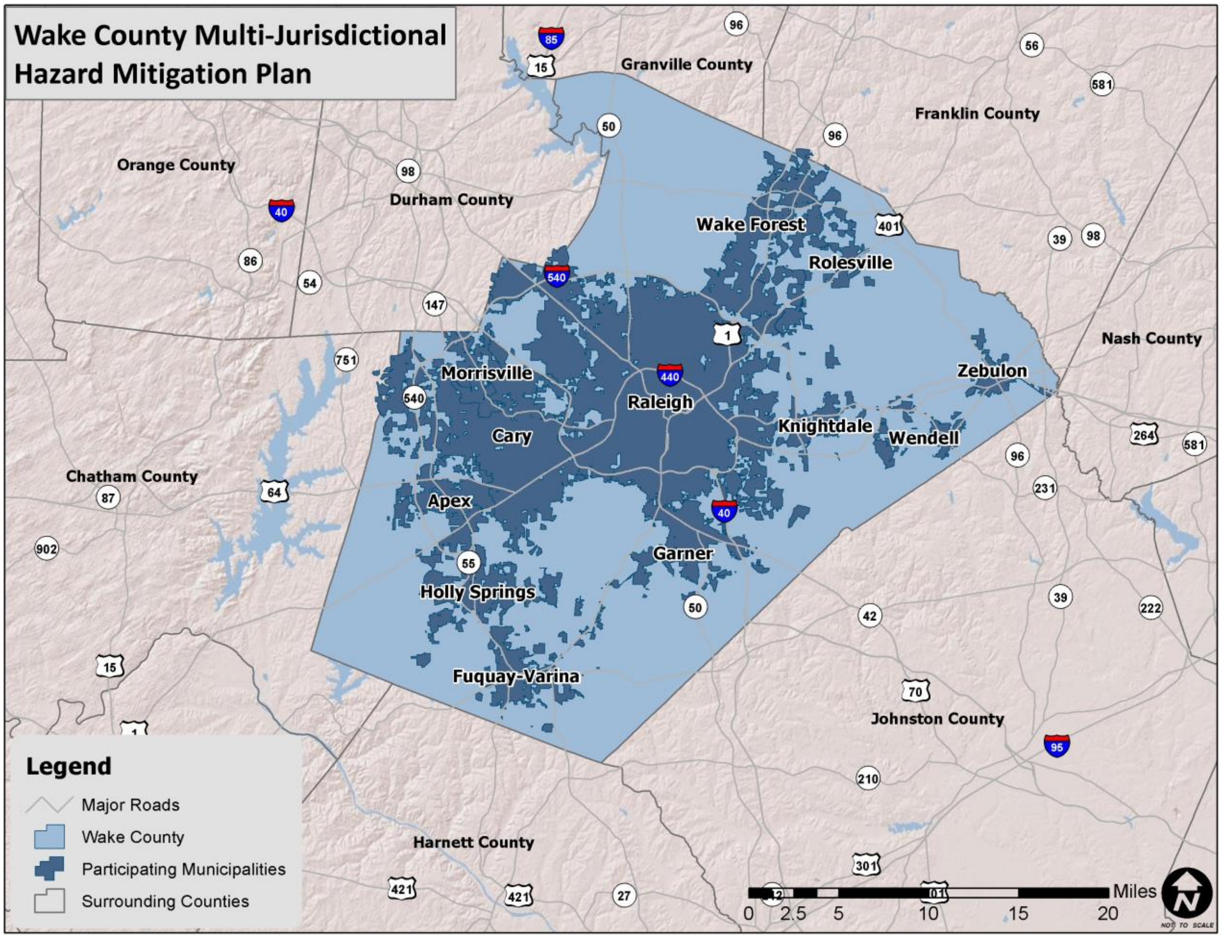


Table 5.2 lists each significant hazard for Wake County and identifies whether or not it has been determined to be a specific hazard of concern for the county and twelve municipal jurisdictions. This is based on the best available data and information from the Regional Work Groups. (● = hazard of concern)

TABLE 5.2 SUMMARY OF IDENTIFIED HAZARD EVENTS IN WAKE COUNTY

Jurisdiction	Atmospheric								Geologic		Hydrologic			Other			
	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm	Earthquake	Landslide	Dam and Levee Failure	Erosion	Flood	HAZMAT	Wildfire	Nuclear Accident	Terror Threat
Wake County																	
Apex	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Cary	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Fuquay-Varina	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Garner	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Jurisdiction	Atmospheric								Geologic		Hydrologic			Other			
	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm	Earthquake	Landslide	Dam and Levee Failure	Erosion	Flood	HAZMAT	Wildfire	Nuclear Accident	Terror Threat
Holly Springs	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Knightdale	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Morrisville	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Raleigh	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Rolesville	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Wake Forest	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Wendell	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Zebulon	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Unincorporated Area	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●

Atmospheric Hazards

5.3 DROUGHT

5.3.1 Background

Drought is a normal part of virtually all climatic regions, including areas with high and low average rainfall. Drought is the consequence of a natural reduction in the amount of precipitation expected over an extended period of time, usually a season or more in length. High temperatures, high winds, and low humidity can exacerbate drought conditions. In addition, human actions and demands for water resources can hasten drought-related impacts.

Droughts are typically classified into one of four types: 1) meteorological, 2) hydrologic, 3) agricultural, or 4) socioeconomic. **Table 5.3** presents definitions for these types of drought.

TABLE 5.3 DROUGHT CLASSIFICATION DEFINITIONS

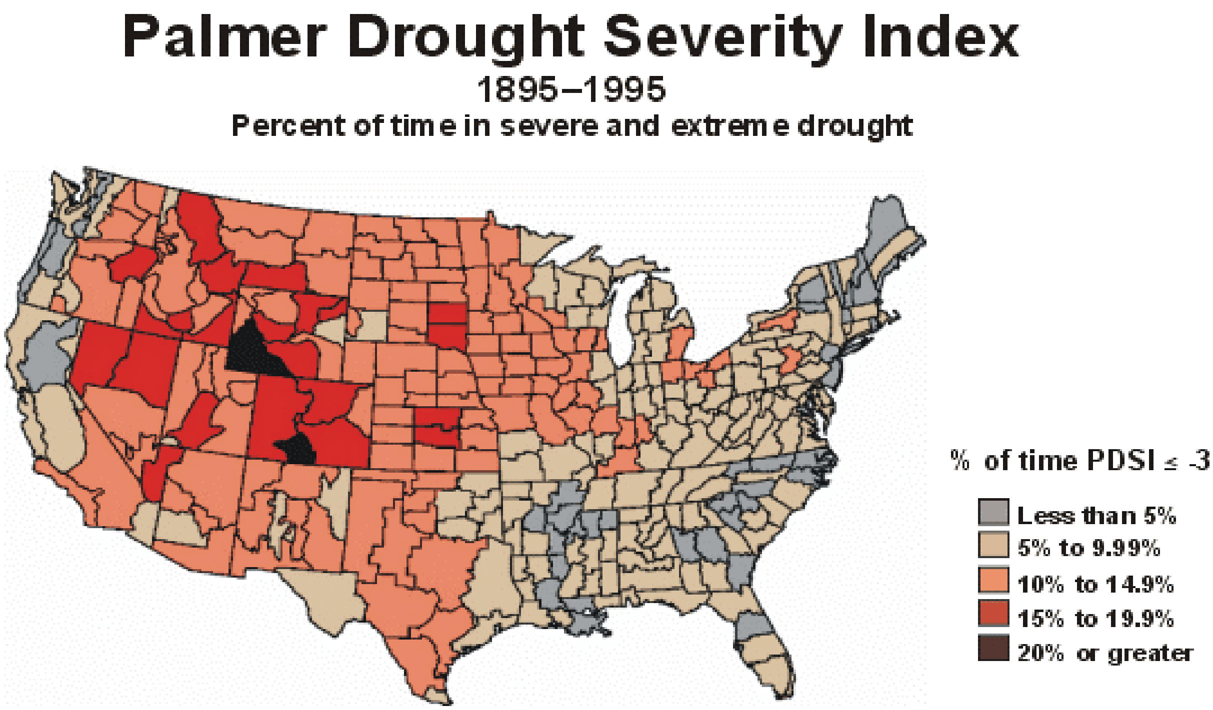
Meteorological Drought	The degree of dryness or departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
Hydrologic Drought	The effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
Agricultural Drought	Soil moisture deficiencies relative to water demands of plant life, usually crops.
Socioeconomic Drought	The effect of demands for water exceeding the supply as a result of a weather-related supply shortfall.

Source: Multi-Hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy, FEMA

Droughts are slow-onset hazards, but, over time, can have very damaging affects to crops, municipal water supplies, recreational uses, and wildlife. If drought conditions extend over a number of years, the direct and indirect economic impact can be significant.

The Palmer Drought Severity Index (PDSI) is based on observed drought conditions and range from -0.5 (incipient dry spell) to -4.0 (extreme drought). Evident in **Figure 5.2**, the Palmer Drought Severity Index Summary Map for the United Stated, drought affects most areas of the United States, but is less severe in the Eastern United States.

FIGURE 5.2: PALMER DROUGHT SEVERITY INDEX SUMMARY MAP FOR THE UNITED STATES



Source: National Drought Mitigation Center

5.3.2 Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index (**Figure 5.2**), Central North Carolina has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that Wake County would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

5.3.3 Historical Occurrences

Data from the North Carolina Drought Management Advisory Council and National Climatic Data Center (NCDC) were used to ascertain historical drought events in Wake County. The North Carolina Drought Management Advisory Council reports data on North Carolina drought conditions from 2000 to 2013 through the North Carolina Drought Monitor. It classifies drought conditions by county on a scale of D0 to D4:

- D0: Abnormally Dry
- D1: Moderate Drought
- D2: Severe Drought
- D3: Extreme Drought
- D4: Exceptional Drought

According to the North Carolina Drought Monitor, Wake County has had drought occurrences in all of the last fourteen years (2000-2013) (**Table 5.4**). In addition, **Table 5.5** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE 5.4: SUMMARY OF DROUGHT OCCURRENCES IN WAKE COUNTY

Location	Number Years with Drought Occurrences	Number Years with Exceptional Drought Occurrences
Wake County	**14**	**3**

Source: North Carolina Drought Monitor

TABLE 5.5: HISTORICAL DROUGHT OCCURRENCES IN WAKE COUNTY

Abnormally Dry **Moderate Drought** **Severe Drought** **Extreme Drought** **Exceptional Drought**

	Wake County
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

5.3.4 Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location but all areas have an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

5.3.5 Consequence Analysis

People (The Public and Public Confidence)

Drought can have a detrimental effect on the livelihood of farmers and agricultural producers in Wake County. Efforts to mitigate against drought, such as using irrigation equipment, have a high initial cost, including the need for an increase in management requirements, cost of operation and maintenance, and the lack of good quality water resources—which during times of drought would be severely affected. Public confidence would likely not be impacted severely.

Responders

Although drought would have many of the same impacts on responders as it would on the public, the overall effects would be relatively limited when compared to other hazards.

Continuity of Operations

Drought would have minimal impacts on continuity of operations due to the relatively long warning time that would allow for plans to be made to maintain continuity of operations.

Built Environment (Property, Facilities, and Infrastructure)

Water Use

Drought has the potential to affect Wake County's water supply for residential, commercial, institutional, industrial, and government-owned areas. Drought can reduce water supply in wells and reservoirs. When drought conditions persist with no relief, local or State governments often institute water restrictions.

Irrigation

Drought would affect irrigation and outdoor landscaping efforts around residential, commercial, institutional, industrial, and government-owned land. Water conservation strategies can limit the amount of water used to maintain the aesthetic environment around buildings, businesses, and areas such as golf courses. This would include automatic and non-automatic spray irrigation systems, hose-end sprinklers, handheld hoses, bucket watering, drip irrigation, athletic field irrigation, swimming pools, car washing, pressure washing, and reuse water.

Economy

Drought can have a detrimental effect on agricultural and agribusiness industry sectors. In 2000, all agricultural and agribusiness industries in the United States encompassed $2,330,828,659, which is 8.19 percent share of the county income.[1] In addition, in 2000, employment in agriculture and agribusiness was 64,367, or 13 percent of the county's total employment.

Extreme drought has the potential to depress local businesses and industries such as landscaping, recreation and tourism, and public utilities. Nursery and landscape businesses can also face significant losses from a drought. Losses include reduction of output and sales of nursery crops, reduction in plant sales, and an increase in watering costs. This can lead to the closing of many business locations, lay-off of employees, and increases in bankruptcy filing.

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[1] North Carolina State University College of Agriculture and Life Sciences. (2003). *Agriculture and agribusiness in Wake County*. Retrieved May 7, 2012, from http://www.cals.ncsu.edu/cfprod/apps/calswebsite/documents/County/wake.pdf

Environment

Agriculture

The agriculture sector of Wake County is particularly susceptible to drought damage. **Table 5.6** shows there are 827 farms in Wake County, with 84,956 acres of 532,415 acres total being farmland.[2] Agricultural drought has the potential to directly affect almost 16.0 percent of the land in Wake County. Agricultural areas at particular risk are cropland (54.05 percent of farmland in Wake County) and pastures (10.67 percent of farmland in Wake County).

TABLE 5.6: WAKE COUNTY FARMLAND OVERVIEW

Census of Agriculture (2007)	
Total Acres in County	532,415
Number of Farms	827
Total Land in Farms, Acres	84,956
Average Farm Size, Acres	103
Median Farm Size, Acres	38

Crops

Prolonged periods of dry weather are the most difficult and damaging problem faced by crop growers and agricultural suppliers. Wake County has 35,610 acres (6.69 percent) of harvested cropland (see **Table 5.7**).

TABLE 5.7: WAKE COUNTY AGRICULTURE INFORMATION

Census of Agriculture (2007)	
Harvested Cropland, Acres	35,610
Irrigated land, Acres	3,764

Short- or long-term moisture deficits—even with the use of irrigation methods—during critical stages of crop development can severely reduce yields, with the amount of yield lost depending on when the drought occurs (see **Table 5.8**for a list of Wake County crop specific information), the growth stage of the crop, the severity of dry conditions, and the amount of available water that the soil can hold.

TABLE 5.8: WAKE COUNTY CROP INFORMATION

Crops	Farms	Acres	Bushels
Corn for Grain	53	2,224	152,018
Wheat for grain, all	44	3,238	126,880
Winter wheat for grain	44	3,238	126,880
Oats for grain	20	493	25,930

Livestock[3]

Table 5.9shows the type of livestock in Wake County, including the number of farms and the quantity of livestock that are at risk for being affected by drought conditions in the county, based on the 2007 Agriculture Census.

[2] *Wake County: Census of agriculture—2007*. Retrieved May 7, 2012, from http://www.ncagr.gov/stats/codata/wake.pdf

[3] North Carolina Division of Water Resources. (2009). *The water connection: Water resources, drought and the hydrologic cycle in North Carolina*. Retrieved May 7, 2012, from http://www.ncwater.org/Reports_and_Publications/primer/The_Water_Connection_Booklet_9x12_150dpi.pdf

Livestock losses from drought will most likely be confined to forage-based production systems. Losses in beef and dairy systems will potentially be of a single-season or multiyear variety. Single-season losses will include lost forage production (on both hay and grazing land), reduced weaning weights, reduced milk production, and increased mortality.

Multiyear losses could include the cost of reestablishing pastures and reduced meat or milk production in subsequent years due to forced sales in the drought year. In addition, drought conditions could result in poor pasture conditions, reduced drinking water supplies, and a critical hay shortage that directly affects livestock and poultry health.

TABLE 5.9: WAKE COUNTY LIVESTOCK (2010)

Livestock	Farms	Number
Cattle and calves inventory	159	4,392
Beef cows	121	-
Milk cows	5	-
Cattle and calves sold	134	1812
Hogs and pigs inventory	8	-
Hogs and pigs sold	-	30
Sheep and lambs inventory	581	71
Layers inventory	71	24,534
Broilers and other meat-type chickens sold	10	-

Environmental Degradation
Drought may also lead to pollution of water sources as a result of lack of rain water to dilute industrial and agricultural chemical runoff. This poses a risk to plants and animals and makes it difficult to maintain a clean drinking water supply.

Lack of water reaching the soil may also cause the ground to become dry and unstable. Erosion can increase and loss of topsoil can be severe if a high-intensity rain falls on ground lacking a ground cover of plants. As a result of these environmental impacts, habitats may be degraded through a loss of wetlands, lake capacity, and vegetation.

5.4 EXTREME HEAT

5.4.1 Background

Extreme heat, like drought, poses little risk to property. However, extreme heat can have devastating effects on health. Extreme heat is often referred to as a “heat wave.” According to the National Weather Service, there is no universal definition for a heat wave, but the standard U.S. definition is any event lasting at least three days where temperatures reach ninety degrees Fahrenheit or higher. However, it may also be defined as an event at least three days long where temperatures are ten degrees greater than the normal temperature for the affected area. Heat waves are typically accompanied by humidity but may also be very dry. These conditions can pose serious health threats causing an average of 1,500 deaths each summer in the United States[4].

[4] http://www.noaawatch.gov/themes/heat.php

According to the National Oceanic and Atmospheric Administration, heat is the number one weather-related killer among natural hazards, followed by frigid winter temperatures[1]. The National Weather Service devised the Heat Index as a mechanism to better inform the public of heat dangers. The Heat Index Chart, shown in **Figure 5.3**, uses air temperature and humidity to determine the heat index or apparent temperature. **Table 5.10** shows the dangers associated with different heat index temperatures. Some populations, such as the elderly and young, are more susceptible to heat danger than other segments of the population.

FIGURE 5.3: HEAT INDEX CHART

Relative Humidity (in percent)

Air Temp (in F)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
140	125																				
135	120	128																			
130	117	122	131																		
125	111	116	123	131	141																
120	107	111	116	123	130	139	148														
115	103	107	111	115	120	127	135	143	151												
110	99	102	105	108	112	117	123	130	137	143	150										
105	95	97	100	102	105	109	113	118	123	129	135	142	149								
100	91	93	95	97	99	101	104	107	110	115	120	126	132	138	144						
95	87	88	90	91	93	94	96	98	101	104	107	110	114	119	124	130	136				
90	83	84	85	86	87	88	90	91	93	95	96	98	100	102	106	109	113	117	122		
85	78	79	80	81	82	83	84	85	86	87	88	89	90	91	93	95	97	99	102	105	108
80	73	74	75	76	77	77	78	79	79	80	81	81	82	83	85	86	86	87	88	89	91
75	69	69	70	71	72	72	73	73	74	74	75	75	76	76	77	77	78	78	79	79	80
70	64	64	65	65	66	66	67	67	68	68	69	69	70	70	70	70	71	71	71	71	72

Source: NOAA

TABLE 5.10: HEAT DISORDERS ASSOCIATED WITH HEAT INDEX TEMPERATURE

Heat Index Temperature (Fahrenheit)	Description of Risks
80°- 90°	Fatigue possible with prolonged exposure and/or physical activity
90°- 105°	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and/or physical activity
105°- 130°	Sunstroke, heat cramps, and heat exhaustion likely, and heatstroke possible with prolonged exposure and/or physical activity
130° or higher	Heatstroke or sunstroke is highly likely with continued exposure

Source: National Weather Service, NOAA

In addition, NOAA has seventeen metropolitan areas participating in the Heat HealthWatch/Warning System in order to better inform and warn the public of heat dangers. A Heat HealthWatch is issued when conditions are favorable for an excessive heat event in the next 12 to 48 hours. A Heat Warning is issued when an excessive heat event is expected in the next 36 hours. Furthermore, a warning is issued when the conditions are occurring, imminent, or have a high likelihood of occurrence. Urban areas participate in the Heat Health Watch/Warning System because urban areas are at greater risk to heat affects. Stagnant atmospheric conditions trap pollutants, thus adding unhealthy air to excessively hot temperatures. In addition, the "urban heat island effect" can produce significantly higher nighttime temperatures because asphalt and concrete (which store heat longer) gradually release heat at night.

5.4.2 Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to any geographic or political boundaries. All of Wake County is susceptible to extreme heat conditions.

5.4.3 Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Wake County. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the county. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the region. The most centralized location is in Raleigh at North Carolina State University. **Table 5.11** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table 5.11: AVERAGE MAXIMUM TEMPERATURE IN RALEIGH, WAKE COUNTY

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

5.4.4 Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

5.4.5 Consequence Analysis

People (The Public and Public Confidence)

Extreme heat can affect many people and to varying degrees. Often the elderly and very young are susceptible to the most detrimental impacts, but heat stroke and exhaustion can plague anyone. A heat wave would have minimal effects on public confidence.

Responders

Extreme heat can also affect responders who are often more susceptible to heat stroke and exhaustion due to the nature of their work which often forces police and emergency medical providers to be exposed to the elements. In these cases, responders could be negatively impacted by extreme heat.

Continuity of Operations

Extreme heat would likely have few impacts on continuity of operations as the warning time for these events is usually long and direct impacts to large numbers of personnel or other resources necessary to maintain operations are unlikely.

Built Environment (Property, Facilities, and Infrastructure)

Extreme heat would likely have a minor effect on the built environment, although high temperatures could potentially put a strain on infrastructure such as power generation and water systems due to higher demand.

Economy

An extreme heat event could potentially have a negative impact on the economy in the short term as the public may be advised to stay inside, causing them to reduce overall spending and negatively impact businesses in the community. Extended periods of extreme heat may also disrupt the local economy if agricultural, dairy, and livestock production declines, resulting in income loss for famers and others affected.

Environment

The environment would be impacted by extreme heat as many plants and animals that are not able to withstand the heat may die off and crops and livestock may be impacted by unusually high temperatures, resulting in death or illness.

5.5 HAILSTORM

5.5.1 Background

Hailstorms are a potentially damaging outgrowth of severe thunderstorms (thunderstorms are discussed separately in Section 5.8). Early in the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until they develop to a sufficient weight and fall as precipitation. Hail typically takes the form of spheres or irregularly-shaped masses greater than 0.75 inches in diameter. The size of hailstones is a direct function of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface. Higher temperature gradients relative to elevation above the surface result in increased suspension time and hailstone size.

5.5.2 Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Wake County is uniformly exposed to severe thunderstorms; therefore, all areas of the region are equally exposed to hail which may be produced by such storms.

5.5.3 Historical Occurrences

According to the National Climatic Data Center, 261 recorded hailstorm events have affected Wake County since 1966.[5] **Table 5.12** is a summary of the hail events in Wake County. **Table 5.13** provides detailed information about each event that occurred in the region. In all, hail occurrences resulted in around $9,000 (2013 dollars) in property damages. Hail ranged in diameter from 0.75 inches to 4.0 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value. Additionally, a single storm event may have affected multiple jurisdictions.

TABLE 5.12: SUMMARY OF HAIL OCCURRENCES IN WAKE COUNTY

Location	Number of Occurrences	Property Damage (2013)
Apex	12	$0
Cary	22	$9,008
Fuquay-Varina	10	0
Garner	13	$0
Holly Springs	7	$0
Knightdale	8	$0
Morrisville	7	$0
Raleigh	55	$0
Rolesville	5	$0
Wake Forest	8	$0
Wendell	6	$0
Zebulon	6	$0
Unincorporated Area	102	$0
WAKE COUNTY TOTAL	**261**	**$9,008**

Source: National Climatic Data Center

TABLE 5.13: HISTORICAL HAIL OCCURRENCES IN WAKE COUNTY

	Date	Magnitude	Deaths/Injuries	Property Damage*
Wake County				
Wake County	8/15/1958	1 in.	0/0	$0

[5] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Wake County. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

	Date	Magnitude	Deaths/Injuries	Property Damage*
Wake County	3/19/1966	1 in.	0/0	$0
Wake County	3/19/1966	1 in.	0/0	$0
Wake County	2/9/1970	0.75 in.	0/0	$0
Wake County	5/23/1973	0.75 in.	0/0	$0
Wake County	5/28/1973	1.75 in.	0/0	$0
Wake County	4/8/1976	1.5 in.	0/0	$0
Wake County	4/19/1978	1.25 in.	0/0	$0
Wake County	4/19/1978	1 in.	0/0	$0
Wake County	6/22/1978	1 in.	0/0	$0
Wake County	4/27/1980	1.75 in.	0/0	$0
Wake County	4/27/1980	0.75 in.	0/0	$0
Wake County	4/27/1980	0.75 in.	0/0	$0
Wake County	4/30/1981	0.75 in.	0/0	$0
Wake County	6/3/1982	1 in.	0/0	$0
Wake County	6/3/1982	1.75 in.	0/0	$0
Wake County	6/3/1982	2 in.	0/0	$0
Wake County	6/16/1982	2 in.	0/0	$0
Wake County	5/26/1983	0.75 in.	0/0	$0
Wake County	4/16/1985	0.75 in.	0/0	$0
Wake County	6/24/1986	1.75 in.	0/0	$0
Wake County	6/24/1986	1.75 in.	0/0	$0
Wake County	8/2/1986	0.75 in.	0/0	$0
Wake County	7/13/1987	1.5 in.	0/0	$0
Wake County	8/21/1987	1.75 in.	0/0	$0
Wake County	10/6/1987	1 in.	0/0	$0
Wake County	5/17/1988	1.75 in.	0/0	$0
Wake County	5/19/1988	1 in.	0/0	$0
Wake County	5/19/1988	1 in.	0/0	$0
Wake County	6/2/1988	2 in.	0/0	$0
Wake County	6/2/1988	0.75 in.	0/0	$0
Wake County	6/17/1988	1 in.	0/0	$0
Wake County	7/19/1988	0.75 in.	0/0	$0
Wake County	7/31/1988	1 in.	0/0	$0
Wake County	9/24/1988	2.5 in.	0/0	$0
Wake County	4/25/1989	1.75 in.	0/0	$0
Wake County	6/15/1989	0.88 in.	0/0	$0
Wake County	6/16/1989	3 in.	0/0	$0
Wake County	4/2/1990	1 in.	0/0	$0
Wake County	5/4/1990	1.5 in.	0/0	$0
Wake County	6/3/1990	1 in.	0/0	$0
Wake County	7/1/1990	2.5 in.	0/0	$0
Wake County	8/29/1990	1.75 in.	0/0	$0
Wake County	8/29/1990	0.75 in.	0/0	$0
Wake County	6/26/1992	0.75 in.	0/0	$0
Wake County	6/26/1992	1 in.	0/0	$0
Wake County	7/26/1992	1 in.	0/0	$0
Wake County	9/4/1992	1.5 in.	0/0	$0

	Date	Magnitude	Deaths/Injuries	Property Damage*
New Hill	3/27/1993	0.75 in.	0/0	$0
New Hill	5/19/1993	1.75 in.	0/0	$0
Wake County	5/1/1994	0.75 in.	0/0	$0
Wake County	5/26/1995	1.75 in.	0/0	$0
FALLS LAKE	5/11/1996	0.75 in.	0/0	$0
CARPENTER	3/21/1999	1 in.	0/0	$0
SHOTWELL	8/13/2000	0.88 in.	0/0	$0
NEW HILL	5/14/2006	0.75 in.	0/0	$0
FALLS	5/20/2006	0.75 in.	0/0	$0
BAYLEAF	5/9/2008	0.75 in.	0/0	$0
WAKE XRDS	5/9/2008	0.75 in.	0/0	$0
WILLOW SPGS	5/9/2008	0.88 in.	0/0	$0
NEWHILL	5/20/2008	1.75 in.	0/0	$0
WILLOW	5/20/2008	0.88 in.	0/0	$0
MACEDONIA	5/20/2008	0.75 in.	0/0	$0
WILLOW SPGS	5/20/2008	1 in.	0/0	$0
MACEDONIA	7/6/2008	0.75 in.	0/0	$0
MILLBROOK	7/22/2008	0.75 in.	0/0	$0
FAWLERS XRDS	5/5/2009	0.88 in.	0/0	$0
WILLOW SPGS	7/1/2009	0.75 in.	0/0	$0
FALLS	7/27/2009	1 in.	0/0	$0
LEESVILLE	7/28/2009	0.88 in.	0/0	$0
WILLIAMS XRDS	8/5/2009	0.88 in.	0/0	$0
ROYAL MILLS	2/28/2011	1 in.	0/0	$0
SIX FORKS	8/29/2011	1.25 in.	0/0	$0
ECHO HGTS	3/31/2012	0.75 in.	0/0	$0
AUBURN	3/31/2012	1.25 in.	0/0	$0
PET XRDS	5/4/2012	1 in.	0/0	$0
AUBURN	5/17/2012	1.25 in.	0/0	$0
AUBURN	5/23/2012	1.25 in.	0/0	$0
FORESTVILLE	5/23/2012	1 in.	0/0	$0
STARMOUNT	5/23/2012	1 in.	0/0	$0
STARMOUNT	5/23/2012	1 in.	0/0	$0
STARMOUNT	5/23/2012	1 in.	0/0	$0
BAYLEAF	7/1/2012	1 in.	0/0	$0
BAYLEAF	7/1/2012	1.75 in.	0/0	$0
UPCHURCH	7/1/2012	1 in.	0/0	$0
FAWLERS XRDS	7/1/2012	1 in.	0/0	$0
FAWLERS XRDS	7/1/2012	1.5 in.	0/0	$0
BAYLEAF	7/1/2012	1.75 in.	0/0	$0
FALLS	7/1/2012	1 in.	0/0	$0
UPCHURCH	7/1/2012	1.75 in.	0/0	$0
SIX FORKS	7/1/2012	1 in.	0/0	$0
AUBURN	7/1/2012	1 in.	0/0	$0
FALLS	7/6/2012	1 in.	0/0	$0
STARMOUNT	7/6/2012	1.75 in.	0/0	$0
Apex				

	Date	Magnitude	Deaths/Injuries	Property Damage*
Apex	5/19/1993	1.75 in.	0/0	$0
Apex	5/19/1993	1 in.	0/0	$0
Apex	5/19/1993	1.75 in.	0/0	$0
Apex	3/23/1995	1.75 in.	0/0	$0
APEX	3/21/1999	0.75 in.	0/0	$0
APEX	4/22/2006	1 in.	0/0	$0
APEX	5/14/2006	1.75 in.	0/0	$0
APEX	6/13/2007	0.75 in.	0/0	$0
APEX	6/1/2008	0.75 in.	0/0	$0
APEX	6/21/2008	0.88 in.	0/0	$0
APEX	3/23/2011	0.75 in.	0/0	$0
APEX	6/21/2011	1 in.	0/0	$0
Cary				
Cary	5/19/1993	2.25 in.	0/0	$9,008
Cary	5/19/1993	1.75 in.	0/0	$0
CARY	7/2/1996	0.75 in.	0/0	$0
CARY	6/2/1997	1 in.	0/0	$0
CARY	6/2/1997	0.88 in.	0/0	$0
CARY	3/20/1998	0.75 in.	0/0	$0
CARY	5/7/1998	0.75 in.	0/0	$0
CARY	4/29/2000	0.75 in.	0/0	$0
CARY	4/1/2001	0.75 in.	0/0	$0
CARY	5/12/2001	0.75 in.	0/0	$0
CARY	5/12/2001	0.75 in.	0/0	$0
CARY	5/14/2006	0.75 in.	0/0	$0
CARY	5/14/2006	0.75 in.	0/0	$0
CARY	4/21/2008	0.88 in.	0/0	$0
CARY	5/20/2008	0.75 in.	0/0	$0
CARY	5/20/2008	0.75 in.	0/0	$0
CARY	8/30/2008	1 in.	0/0	$0
CARY	8/29/2011	1 in.	0/0	$0
CARY	3/31/2012	1.75 in.	0/0	$0
CARY	5/23/2012	2 in.	0/0	$0
CARY	7/27/2012	1.75 in.	0/0	$0
Fuquay Varina				
FUQUAY SPGS	3/20/1998	0.75 in.	0/0	$0
FUQUAY SPGS	7/10/2003	1.75 in.	0/0	$0
FUQUAY SPGS	3/31/2004	0.75 in.	0/0	$0
VARINA	5/14/2006	1 in.	0/0	$0
FUQUAY SPGS	5/14/2006	1 in.	0/0	$0
FUQUAY SPGS	5/14/2006	1 in.	0/0	$0
FUQUAY SPGS	5/14/2006	1 in.	0/0	$0
FUQUAY SPGS	5/14/2006	1.25 in.	0/0	$0
FUQUAY SPGS	5/14/2006	1 in.	0/0	$0
FUQUAY SPGS	4/15/2007	1 in.	0/0	$0
FUQUAY SPGS	7/17/2007	0.75 in.	0/0	$0

	Date	Magnitude	Deaths/Injuries	Property Damage*
Garner				
Nr Garner	7/10/1995	0.75 in.	0/0	$0
GARNER	3/20/1998	0.75 in.	0/0	$0
GARNER	5/26/1998	0.75 in.	0/0	$0
GARNER	6/3/2000	1.75 in.	0/0	$0
GARNER	6/14/2000	1 in.	0/0	$0
GARNER	5/19/2004	1 in.	0/0	$0
GARNER	6/7/2005	1 in.	0/0	$0
GARNER	4/3/2006	1.75 in.	0/0	$0
GARNER	5/14/2006	0.75 in.	0/0	$0
GARNER	5/14/2006	1 in.	0/0	$0
GARNER	5/14/2006	1.75 in.	0/0	$0
GARNER	5/14/2006	0.88 in.	0/0	$0
GARNER	5/14/2006	1.75 in.	0/0	$0
GARNER	5/20/2006	0.75 in.	0/0	$0
Holly Springs				
HOLLY SPGS	6/3/2000	0.75 in.	0/0	$0
HOLLY SPGS	6/1/2001	0.75 in.	0/0	$0
HOLLY SPGS	5/29/2007	1 in.	0/0	$0
HOLLY SPGS	4/27/2008	0.75 in.	0/0	$0
HOLLY SPGS	5/9/2008	0.75 in.	0/0	$0
HOLLY SPGS	5/20/2008	1.75 in.	0/0	$0
HOLLY SPGS	5/23/2012	0.88 in.	0/0	$0
Knightdale				
KNIGHTDALE	5/29/1996	0.75 in.	0/0	$0
KNIGHTDALE	5/7/1998	0.75 in.	0/0	$0
KNIGHTDALE	4/1/2001	1 in.	0/0	$0
KNIGHTDALE	8/5/2004	0.75 in.	0/0	$0
KNIGHTDALE	3/28/2005	0.75 in.	0/0	$0
KNIGHTDALE	5/25/2006	1.75 in.	0/0	$0
KNIGHTDALE	5/20/2008	0.75 in.	0/0	$0
KNIGHTDALE	5/5/2009	1 in.	0/0	$0
Morrisville				
Morrisville	7/10/1994	0.75 in.	0/0	$0
MORRISVILLE	7/14/2004	0.88 in.	0/0	$0
MORRISVILLE	5/9/2008	0.75 in.	0/0	$0
MORRISVILLE	5/20/2008	1.5 in.	0/0	$0
MORRISVILLE	5/20/2008	0.88 in.	0/0	$0
MORRISVILLE	6/14/2008	0.75 in.	0/0	$0
MORRISVILLE	5/5/2009	0.75 in.	0/0	$0
Raleigh				
Raleigh	3/27/1993	0.75 in.	0/0	$0
Raleigh	3/27/1993	0.75 in.	0/0	$0
Raleigh	5/19/1993	1 in.	0/0	$0
Raleigh	5/19/1993	0.75 in.	0/0	$0
RALEIGH, WAKE	5/29/1996	0.75 in.	0/0	$0

	Date	Magnitude	Deaths/Injuries	Property Damage*
FOREST				
RALEIGH	7/31/1996	0.75 in.	0/0	$0
RALEIGH DURHAM ARPT	3/5/1997	1 in.	0/0	$0
NW RALEIGH	5/1/1997	0.75 in.	0/0	$0
2S RDU AIRPORT	5/1/1997	0.88 in.	0/0	$0
RALEIGH	5/1/1997	0.75 in.	0/0	$0
RALEIGH	5/1/1997	0.75 in.	0/0	$0
RALEIGH, CARY, APEX	6/2/1997	1.75 in.	0/0	$0
RALEIGH	6/2/1997	0.75 in.	0/0	$0
NW RALEIGH	7/4/1997	1 in.	0/0	$0
N RALEIGH	7/16/1997	0.75 in.	0/0	$0
RALEIGH	5/8/1998	1 in.	0/0	$0
RALEIGH	5/27/1998	0.75 in.	0/0	$0
RALEIGH	6/15/1998	1.75 in.	0/0	$0
RALEIGH	6/23/1998	1 in.	0/0	$0
RALEIGH	7/4/1998	0.75 in.	0/0	$0
RALEIGH	7/6/1999	0.75 in.	0/0	$0
RALEIGH	5/28/2000	0.75 in.	0/0	$0
RALEIGH	6/3/2000	1 in.	0/0	$0
RALEIGH	6/14/2000	1.75 in.	0/0	$0
RALEIGH	7/17/2000	1.75 in.	0/0	$0
RALEIGH DURHAM ARPT	4/1/2001	0.75 in.	0/0	$0
RALEIGH	3/26/2002	0.88 in.	0/0	$0
RALEIGH	3/31/2002	0.88 in.	0/0	$0
RALEIGH	7/4/2002	0.75 in.	0/0	$0
RALEIGH	3/31/2004	0.88 in.	0/0	$0
RALEIGH	7/14/2004	0.88 in.	0/0	$0
RALEIGH	5/12/2005	1 in.	0/0	$0
RALEIGH	7/13/2005	2 in.	0/0	$0
RALEIGH	10/21/2005	4 in.	0/0	$0
RALEIGH	10/21/2005	0.75 in.	0/0	$0
RALEIGH	4/3/2006	0.88 in.	0/0	$0
RALEIGH	4/22/2006	1.75 in.	0/0	$0
RALEIGH	5/14/2006	1 in.	0/0	$0
RALEIGH	5/14/2006	1 in.	0/0	$0
RALEIGH	5/14/2006	1.75 in.	0/0	$0
RALEIGH	5/20/2006	0.75 in.	0/0	$0
RALEIGH	5/20/2006	1.75 in.	0/0	$0
RALEIGH	5/20/2006	1 in.	0/0	$0
RALEIGH	5/25/2006	1 in.	0/0	$0
RALEIGH	6/6/2006	0.75 in.	0/0	$0
RALEIGH	6/11/2006	1 in.	0/0	$0
RALEIGH	7/27/2006	0.75 in.	0/0	$0
RALEIGH	4/11/2007	0.75 in.	0/0	$0
PURNELL	4/15/2007	0.75 in.	0/0	$0

	Date	Magnitude	Deaths/Injuries	Property Damage*
RALEIGH	4/15/2007	0.88 in.	0/0	$0
RALEIGH	6/29/2007	0.75 in.	0/0	$0
RALEIGH	6/29/2007	0.88 in.	0/0	$0
RALEIGH	7/17/2007	0.75 in.	0/0	$0
RALEIGH	7/17/2007	1 in.	0/0	$0
RALEIGH	7/17/2007	1 in.	0/0	$0
RALEIGH	7/17/2007	0.75 in.	0/0	$0
RALEIGH	7/27/2007	1 in.	0/0	$0
Rolesville				
Rolesville	6/12/1995	1.5 in.	0/0	$0
ROLESVILLE	4/3/2006	1 in.	0/0	$0
ROLESVILLE	5/18/2006	1.75 in.	0/0	$0
ROLESVILLE	5/20/2006	0.88 in.	0/0	$0
ROLESVILLE	5/20/2008	1 in.	0/0	$0
Wake Forest				
WAKE FOREST	5/27/1996	0.75 in.	0/0	$0
WAKE FOREST	4/21/1997	0.75 in.	0/0	$0
WAKE FOREST	6/3/1998	1.25 in.	0/0	$0
WAKE FOREST	6/1/2002	0.75 in.	0/0	$0
WAKE FOREST	4/22/2006	1.75 in.	0/0	$0
WAKE FOREST	4/22/2006	1.75 in.	0/0	$0
WAKE FOREST	4/15/2007	0.88 in.	0/0	$0
WAKE FOREST	6/9/2007	0.88 in.	0/0	$0
Wendell				
Wendell	6/8/1995	0.75 in.	0/0	$0
WENDELL	6/4/1996	1 in.	0/0	$0
WENDELL	5/14/2006	0.75 in.	0/0	$0
WENDELL	5/26/2006	0.75 in.	0/0	$0
WENDELL	6/6/2006	0.75 in.	0/0	$0
WENDELL	5/9/2008	0.75 in.	0/0	$0
Zebulon				
Zebulon	5/26/1995	0.75 in.	0/0	$0
ZEBULON	5/24/1996	1 in.	0/0	$0
ZEBULON	6/3/1998	0.75 in.	0/0	$0
ZEBULON	6/1/2002	1.75 in.	0/0	$0
ZEBULON	3/28/2005	0.75 in.	0/0	$0
ZEBULON	5/25/2006	0.88 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

5.5.4 Probability of Future Occurrences

Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that all of Wake County has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the region.

5.5.5 Consequence Analysis

People (The Public and Public Confidence)
Hail can have a negative impact on the public as it can often cause injury if people are struck by hail stones. Often the impoverished are detrimentally impacted if they cannot find shelter, but hail can impact anyone. There would be little negative impact on public confidence.

Responders
Hail can also affect responders who are often more susceptible to hail events due to the nature of their work which often forces police and emergency medical providers to be exposed to the elements. In these cases, responders could be negatively impacted by hail.

Continuity of Operations
Hail would likely have some impacts on continuity of operations as the warning time for these events is usually shorter and hail stones could potentially knock out power supplies or other critical resources which would affect operations.

Built Environment (Property, Facilities, and Infrastructure)
Hail can often have a significant effect on the built environment, depending on the size of the hail stones. Often these can damage roofs or other parts of homes and businesses as they are essentially rocks that are being propelled at high speeds. Hail can affect most any type of facility or infrastructure as well, causing damage to the structure.

Economy
A hailstorm could negatively impact the economy to some degree if the damage from the storm is large enough. Often hail causes a great deal of damage to personal property such as cars and homes, and these impacts would hurt the overall economy due to recovery efforts.

Environment
Hail often has a serious effect on crops and has been known to cause millions of dollars' worth of damage to farmers. It can also negatively impact livestock, as well as any flora or fauna that is not properly sheltered.

5.6 HURRICANE AND TROPICAL STORM

5.6.1 Background

Hurricanes and tropical storms are classified as cyclones and defined as any closed circulation developing around a low-pressure center in which the winds rotate counter-clockwise in the Northern Hemisphere (or clockwise in the Southern Hemisphere) and whose diameter averages 10 to 30 miles across. A tropical cyclone refers to any such circulation that develops over tropical waters. Tropical cyclones act as a "safety-valve," limiting the continued build-up of heat and energy in tropical regions by maintaining the atmospheric heat and moisture balance between the tropics and the pole-ward latitudes. The primary damaging forces associated with these storms are high-level sustained winds, heavy precipitation, and tornadoes.

The key energy source for a tropical cyclone is the release of latent heat from the condensation of warm water. Their formation requires a low-pressure disturbance, 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. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico during the official Atlantic hurricane season, which encompasses the months of June through November. The peak of the Atlantic hurricane season is in early to mid-September and the average number of storms that reach hurricane intensity per year in the Atlantic basin is about six.

As an incipient hurricane develops, barometric pressure (measured in millibars or inches) at its center falls and winds increase. If the atmospheric and oceanic conditions are favorable, it can intensify into a tropical depression. When maximum sustained winds reach or exceed 39 miles per hour, the system is designated a tropical storm, given a name, and is closely monitored by the National Hurricane Center in Miami, Florida. When sustained winds reach or exceed 74 miles per hour the storm is deemed a hurricane. Hurricane intensity is further classified by the Saffir-Simpson Scale (**Table 5.14**), which rates hurricane intensity on a scale of 1 to 5, with 5 being the most intense.

TABLE 5.14: SAFFIR-SIMPSON SCALE

Category	Maximum Sustained Wind Speed (MPH)	Minimum Surface Pressure (Millibars)
1	74–95	Greater than 980
2	96–110	979–965
3	111–129	964–945
4	130–156	944–920
5	157 +	Less than 920

Source: National Hurricane Center (2012)

The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds and barometric pressure, which are combined to estimate potential damage. Categories 3, 4, and 5 are classified as “major” hurricanes and, while hurricanes within this range comprise only 20 percent of total tropical cyclone landfalls, they account for over 70 percent of the damage in the United States. **Table 5.15** describes the damage that could be expected for each category of hurricane. Damage during hurricanes may also result from spawned tornadoes, storm surge, and inland flooding associated with heavy rainfall that usually accompanies these storms.

TABLE 5.15: HURRICANE DAMAGE CLASSIFICATIONS

Storm Category	Damage Level	Description of Damages	Photo Example
1	MINIMAL	No real damage to building structures. Damage primarily to unanchored mobile homes, shrubbery, and trees. Also, some coastal flooding and minor pier damage.	
2	MODERATE	Some roofing material, door, and window damage. Considerable damage to vegetation, mobile homes, etc. Flooding damages piers and small craft in unprotected moorings may break their moorings.	
3	EXTENSIVE	Some structural damage to small residences and utility buildings, with a minor amount of curtainwall failures. Mobile homes are destroyed. Flooding near the coast destroys smaller structures, with larger structures damaged by floating debris. Terrain may be flooded well inland.	
4	EXTREME	More extensive curtainwall failures with some complete roof structure failure on small residences. Major erosion of beach areas. Terrain may be flooded well inland.	
5	CATASTROPHIC	Complete roof failure on many residences and industrial buildings. Some complete building failures with small utility buildings blown over or away. Flooding causes major damage to lower floors of all structures near the shoreline. Massive evacuation of residential areas may be required.	

Source: National Hurricane Center; Federal Emergency Management Agency

5.6.2 Location and Spatial Extent

Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Wake County and its municipalities. All areas in Wake County are equally susceptible to hurricane and tropical storms.

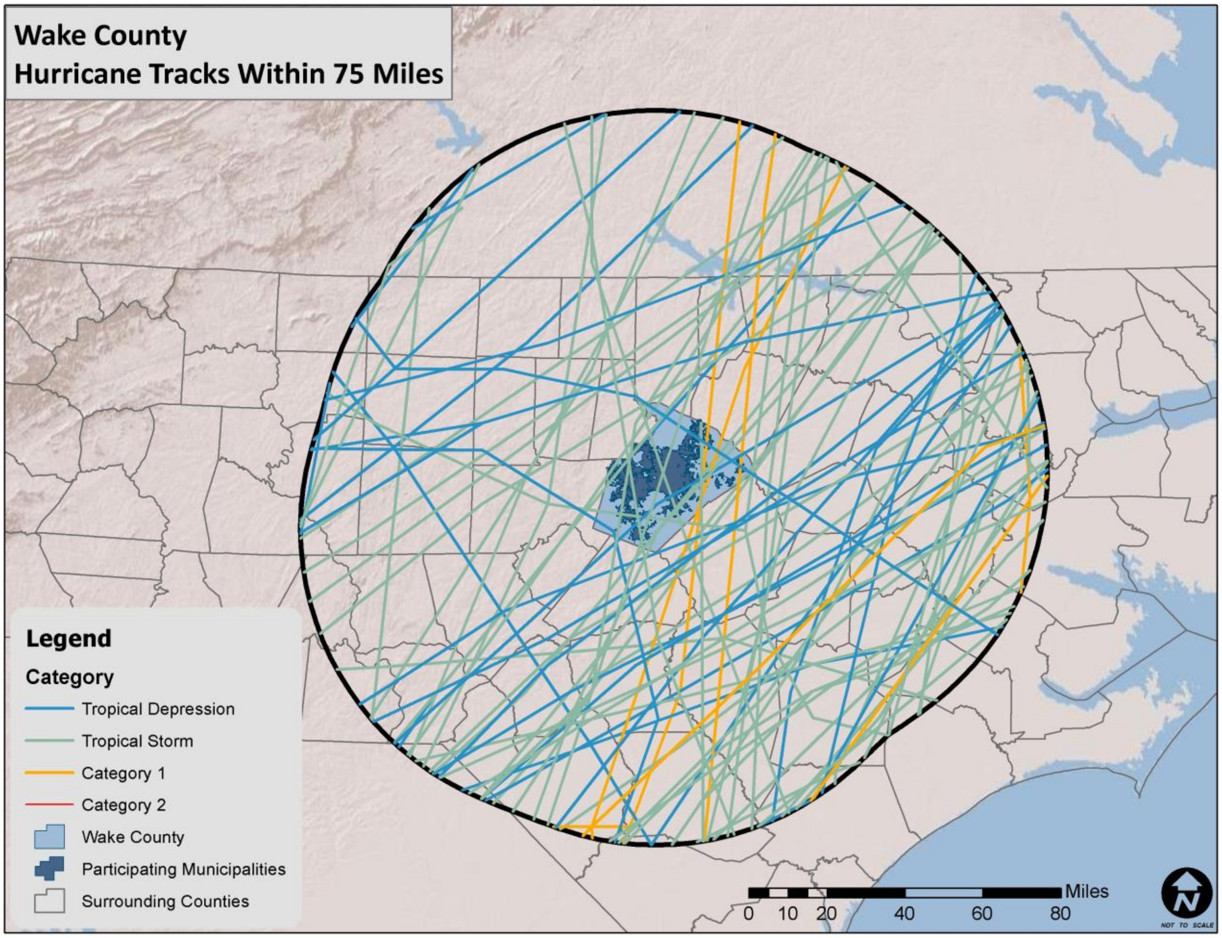
5.6.3 Historical Occurrences

According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[6] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms traversed directly through Wake County as shown in **Figure 5.4**. **Table 5.16** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

[6] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

FIGURE 5.4: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE 5.16: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (knots)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1
1882	NOT NAMED	53	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (knots)	Storm Category
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm
1959	CINDY	26	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (knots)	Storm Category
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression
2008	HANNA	40	Tropical Storm

**Although Hurricane Floyd's track traversed just outside of the 75 mile buffer area, it was included in the hazard history since a federal disaster area was declared for Wake County as a result of the storm's impact.*
Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Wake County between 1950 and 2013. These storms are listed in **Table 5.17** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE 5.17: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made in 1996 (Hurricane Fran), 1999 (Hurricane Floyd), and 2003 (Hurricane Isabel) for the county.[7]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Hurricane Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

5.6.4 Probability of Future Occurrences

Given the inland location of the county, Wake County is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Wake County. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the county is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

[7] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

5.6.5 Consequence Analysis

People (The Public and Public Confidence)
HAZUS-MH estimates the number of households that are expected to be displaced from their homes and the number of displaced people that will require accommodations in temporary public shelters due to a hurricane scenario that was modeled similar to Hurricane Fran in 1996. The model estimates 637 households to be displaced due to the hurricane. Of these, 156 people (out of a total population of 627,846) will seek temporary shelter in public shelters. The total economic loss estimated for the hurricane is $751 million, which represents 1.53 percent of the total replacement value of the county's buildings. This hazard could potentially have a negative effect on public confidence due to the possibility of a high magnitude event and the difficulties that might arise for governments in terms of response and recovery.

Responders
The impacts on responders from this type of storm could potentially be very high as responders may be physically injured or killed during a storm event by flooding or high winds. In addition, their homes and personal effects could also be impacted which would limit their response capability.

In terms of their actual response capacity, downed trees in the wake of a hurricane often block roads and make ingress and egress difficult, thereby causing issues with response time. This is also often true of the resulting floodwaters. Moreover, due to the large scale spatial impact of hurricanes and the number of citizens affected by the storm, response time will be reduced because of the number of incidents that require emergency responders.

Continuity of Operations
Continuity of operations in a hurricane event can be severely affected if power is lost or if critical facilities or infrastructure are damaged during an event. Although Wake County has a plan in place to maintain continuity of operations in the event of a storm, a hurricane with a high magnitude would likely disrupt operations to some degree due to the impacts it would have on personnel.

Built Environment (Property, Facilities, and Infrastructure)
HAZUS-MH estimates that about 8,186 buildings will be at least moderately damaged due to the Category 3 storm. This is over 3 percent of the total number of buildings in the county. There are an estimated 163 buildings that will be completely destroyed. **Table 5.18** summarizes the expected damage by general occupancy for buildings in Wake County, and **Table 5.19** summarizes the expected damage by general building type.

TABLE 5.18 DAMAGE BY GENERAL BUILDING OCCUPANCY IN WAKE COUNTY

Occupancy	None	Minor	Moderate	Severe	Destruction
Agriculture	861 (82.12%)	131 (12.50%)	38 (3.61%)	17 (1.61%)	2 (.16%)
Commercial	12,784 (82.31%)	1,908 (12.28%)	769 (4.95%)	70 (.45%)	1 (.01%)
Education	460 (84.49%)	65 (12.00%)	18 (3.23%)	2 (.28%)	0 (0%)
Government	392 (80.26%)	69 (14.24%)	24 (4.99%)	2 (.51%)	0 (0%)
Industrial	3,797 (85.66%)	479 (10.81%)	132 (2.98%)	22 (.55%)	1 (.03%)
Religion	1,127 (84.26%)	171 (12.78%)	36 (2.73%)	3 (.23%)	0 (0%)

Occupancy	None	Minor	Moderate	Severe	Destruction
Residential	173,128 (79.19%)	38,447 (17.59%)	6,693 (3.06%)	195 (.09%)	159 (.07%)
Total	192,549	41,271	7,711	312	163

TABLE 5.19 DAMAGE BY GENERAL BUILDING TYPE IN WAKE COUNTY

Building Type	None	Minor	Moderate	Severe	Destruction
Concrete	2,677 (79.81%)	477 (14.21%)	194 (5.79%)	6 (.19%)	0 (0%)
Masonry	23,733 (79.53%)	4,180 (14.01%)	1,846 (6.19%)	76 (.25%)	7 (.02%)
MH	13,453 (96.56%)	314 (2.25%)	130 (.93%)	2 (.001%)	34 (.24%)
Steel	9,223 (82.45%)	1,260 (11.26%)	635 (5.68%)	68 (.61%)	1 (.01%)
Wood	145,517 (79.22%)	33,708 (18.35%)	4,157 (2.26%)	176 (.10%)	128 (.07%)
Total	194,603	39,939	6,962	328	170

<u>Economy</u>

Debris Generation

HAZUS-MH estimates the amount of debris that will be generated by the hurricane scenario. The model breaks the debris into three general categories: brick/wood, reinforced concrete/steel, and trees. This distinction is made because of the different types of material-handling equipment required to handle the debris. The model estimates that a total of 623,927 tons of debris will be generated. Of the total amount, brick/wood comprises 20 percent of the total, reinforced concrete/steel comprises 0 percent of the total, and tree debris comprises 80 percent of the total. The total economic loss estimated for the hurricane is $751 million, which represents 1.53 percent of the total replacement value of the county's buildings.

Building-Related Losses

The building-related losses include direct property damage losses and business interruption losses. Direct property damage losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the hurricane. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the hurricane.

TABLE 5.20 BUILDING DAMAGE LOSSES (IN THOUSANDS OF DOLLARS)

Category Area	Residential	Commercial	Industrial	Others	Total
Building	$482,932.2	$57,563.02	$7,848.39	$9,540.64	$557,884.47
Content	$46,139.39	$17,695.36	$4,083.74	$2,969.34	$79,887.82
Inventory	$0	$501.80	$1,009.18	$121.81	$1,632.79
Subtotal	$529,071.59	$75.760.18	$12,941.31	$12,631.79	$639,405.08

Property Damage and Business Interruption

Total property damage losses are $751 million. Four percent of the estimated losses were related to the business interruption of the county. By far, the largest loss was sustained by the residential occupancies which made up over 78 percent of the total loss. **Table 5.20** provides a summary of the losses associated with the building damage, and **Table 5.21** provides a summary of the losses associated with property damage.

TABLE 5.21 PROPERTY DAMAGE LOSSES (IN THOUSANDS OF DOLLARS)

Category Area	Residential	Commercial	Industrial	Others	Total
Income	$.11	$11,463.75	$144.66	$1,546.19	$13,154.72
Relocation	$41,120.72	$15,923.89	$867.87	$2,717.07	$60,629.55
Rental	$19,385.88	$8,314.43	$113.84	$354.26	28,168.41
Wage	$.26	$9,056.99	$243.10	$9,457.60	$18,757.94
Subtotal	$60,506.97	$44,759.06	$1,369.47	$14,075.12	$120,710.62

Environment

Flooding and wind damage are the main impacts that would be felt by a hurricane in Wake County. Please refer to the Flood Hazard Profile for a discussion on flood-related impacts and the Tornado Hazard Profile for a discussion on relevant wind-related impacts.

5.7 LIGHTNING

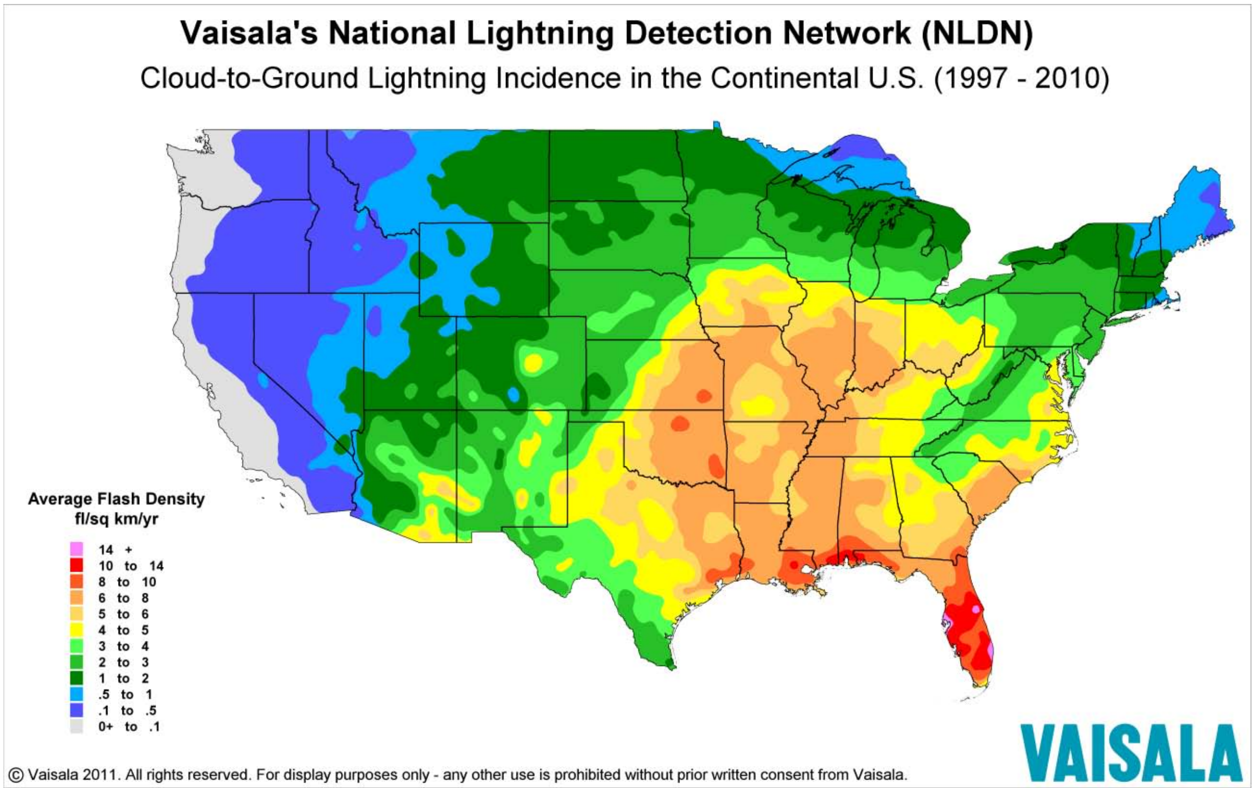
5.7.1 Background

Lightning is a discharge of electrical energy resulting from the buildup of positive and negative charges within a thunderstorm, creating a "bolt" when the buildup of charges becomes strong enough. This flash of light usually occurs within the clouds or between the clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000 degrees Fahrenheit. Lightning rapidly heats the sky as it flashes but the surrounding air cools following the bolt. This rapid heating and cooling of the surrounding air causes the thunder which often accompanies lightning strikes. While most often affiliated with severe thunderstorms, lightning may also strike outside of heavy rain and might occur as far as 10 miles away from any rainfall.

Lightning strikes occur in very small, localized areas. For example, they may strike a building, electrical transformer, or even a person. According to FEMA, lightning injures an average of 300 people and kills 80 people each year in the United States. Direct lightning strikes also have the ability to cause significant damage to buildings, critical facilities, and infrastructure largely by igniting a fire. Lightning is also responsible for igniting wildfires that can result in widespread damages to property.

Figure 5.5 shows a lightning flash density map for the years 1997-2010 based upon data provided by Vaisala's U.S. National Lightning Detection Network (NLDN®).

FIGURE 5.5: LIGHTNING FLASH DENSITY IN THE UNITED STATES



Source: Vaisala U.S. National Lightning Detection Network

5.7.2 Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Wake County is uniformly exposed to lightning.

5.7.3 Historical Occurrences

According to the National Climatic Data Center, there have been a total of 34 recorded lightning events in Wake County since 1950.[8] These events resulted in nearly $3.4 million (2013 dollars) in damages, as listed in summary **Table 5.22**. Furthermore, lightning caused two fatalities throughout Wake County. Detailed information on historical lightning events can be found in **Table 5.23.**

It is certain that more than 34 events have impacted the county. Many of the reported events are those that caused significant damage. Therefore, it should be expected that damages are likely much higher for this hazard than what is reported.

[8] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Wake County. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

TABLE 5.22: SUMMARY OF LIGHTNING OCCURRENCES IN WAKE COUNTY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Apex	2	0/0	$95,703
Cary	6	0/0	$133,182
Fuquay-Varina	1	0/0	$0
Garner	0	0/0	$0
Holly Springs	2	0/0	$1,463,162
Knightdale	2	1/0	$11,255
Morrisville	1	0/0	$5,305
Raleigh	6	0/0	$670,412
Rolesville	0	0/0	$0
Wake Forest	1	0/0	$55,838
Wendell	1	0/0	$622,905
Zebulon	0	0/0	$0
Unincorporated Area	12	1/0	$294,407
WAKE COUNTY TOTAL	**34**	**2/0**	**$3,352,169**

Source: National Climatic Data Center

TABLE 5.23: HISTORICAL LIGHTNING OCCURRENCES IN WAKE COUNTY

	Date	Deaths/ Injuries	Property Damage*	Details
Wake County				
FALLS	7/24/1999	1/0	$0	A man was stepping from his boat onto the dock when he was hit by lightning. He never regained consciousness and died the next day.
MACEDONIA	7/16/2010	0/0	$11,255	A broken line of showers and thunderstorms developed across western North Carolina during the afternoon and then moved east across central and eastern North Carolina during the evening hours
FALLS	7/20/2010	0/0	$11,255	An upper level disturbance combined with strong afternoon heating to produce scattered strong to severe storms. Additional storms then developed along the numerous outflow boundaries.
WILDERS GROVE	7/17/2010	0/0	$11,255	Thunderstorms developed across Virginia and central North Carolina as a small long lived MCS crossed the central and southern Appalachians. Widespread wind damage was reported across northern and central portions of central North Carolina.

	Date	Deaths/ Injuries	Property Damage*	Details
SIX FORKS	7/29/2010	0/0	$2,251	A line of strong to severe storms formed as a cold front moved into a very moist and moderately unstable air mass..
LEESVILLE	7/20/2010	0/0	$16,883	An upper level disturbance combined with strong afternoon heating to produce scattered strong to severe storms. Additional storms then developed along the numerous outflow boundaries.
FORESTVILLE	7/1/2009	0/0	$5,796	A strong upper level disturbance and attendant surface cold front combined to produce scattered showers and thunderstorms across the eastern half of central North Carolina. The unseasonably dry low levels of the atmosphere across central North Carolina created a favorable environment for any thunderstorms that developed to produce damaging winds. Many of the thunderstorms that developed became severe and produced damaging winds across the eastern half of central North Carolina
UPCHURCH	6/15/2010	0/0	$56,275	A broken line of thunderstorms, some which were severe, tracked east across the Northwest and Eastern Piedmont. The storms were associated with a weak upper level disturbance which combined with afternoon heating.
UPCHURCH	6/22/2010	0/0	$140,689	Strong insolation underneath an oppressive upper level heat ridge resulted in isolated pulse severe convection.
WILLOW	6/2/2010	0/0	$28,138	Strong to severe slow moving storms and merging storms resulted in severe damaging winds and flash flooding across portions of Central North Carolina. Frequent to excessive lightning resulted in property damage across the area to homes and businesses.
WYATT	5/9/2012	0/0	$5,305	A cold front moved into central North Carolina and interacted with an unstable air mass to

	Date	Deaths/ Injuries	Property Damage*	Details
				produce scattered showers and thunderstorms. Some of these storms became strong to severe across portions of the Piedmont and Coastal Plain of central North Carolina.
UPCHURCH	7/6/2012	0/0	$5,305	An upper level disturbance moved across central North Carolina and interacted with moderate to strong instability to trigger scattered showers and thunderstorms. Several of these storms became severe and produced damaging winds and a few isolated severe hail reports.
Apex				
Apex	5/19/1993	0/0	$90,075	Lightning caused $5,000 of structural damage to a house.
APEX	7/27/2010	0/0	$5,628	A very moist and moderately unstable air mass combined with a weak upper level disturbance to cause minor flash flooding and an isolated severe storm..
Cary				
CARY	5/3/1998	0/0	$79,768	A large house was struck by lightning on Gold Meadow Drive in Cary. The strike caused an electrical fire that damaged most of the house. Smoke from the fire produced the most damage.
CARY	9/3/2000	0/0	$0	Lightning struck a house.
CARY	3/7/2005	0/0	$26,095	Lighting struck a tree outside a Cary residence. Lightning then entered the natural gas line rupturing the line under the house resulting in a severely damaging fire.
CARY	2/28/2011	0/0	$5,464	A bowing line segment developed ahead of a strong cold front approaching from the west. Despite very strong deep layer shear, marginal instability resulted in only sporadic |reports of wind damage across central North Carolina.
CARY	2/28/2011	0/0	$5,464	A bowing line segment developed ahead of a strong cold front approaching from the west. Despite very strong deep layer shear, marginal instability

	Date	Deaths/ Injuries	Property Damage*	Details
				resulted in only sporadic reports of wind damage across central North Carolina.
CARY	7/24/2011	0/0	$16,391	A cluster of shower and thunderstorms moved off the Appalachians and into central North Carolina during the afternoon. The severe storms produced thunderstorm wind damage across the Central Piedmont with minor structural damage to a couple of outdoor buildings.
Fuquay-Varina				
FUQUAY SPGS	6/22/2001	0/0	$0	Lightning set fire to a house on Bennet Road. Damage amount unknown.
Garner				
None reported				
Holly Springs				
HOLLY SPGS	7/29/2010	0/0	$337,653	A line of strong to severe storms formed as a cold front moved into a very moist and moderately unstable air mass.
HOLLY SPGS	6/2/2010	0/0	$1,125,509	Strong to severe slow moving storms and merging storms resulted in severe damaging winds and flash flooding across portions of Central North Carolina. Frequent to excessive lightning resulted in property damage across the area to homes and businesses.
Knightdale				
KNIGHTDALE	7/13/2005	1/0	$0	A smoldering tree which had been struck by lightning a few hours earlier fell, killing a firefighter.
KNIGHTDALE	7/17/2010	0/0	$11,255	Thunderstorms developed across Virginia and central North Carolina as a small long lived MCS crossed the central and southern Appalachians. Widespread wind damage was reported across northern and central portions of central North Carolina.
Morrisville				
MORRISVILLE	7/6/2012	0/0	$5,305	An upper level disturbance moved across central North Carolina and interacted with moderate to strong instability

	Date	Deaths/ Injuries	Property Damage*	Details
				to trigger scattered showers and thunderstorms. Several of these storms became severe and produced damaging winds and a few isolated severe hail reports.
Raleigh				
Raleigh	7/10/1994	0/0	$87,785	A lightning strike entered a home on New Hope Road and shorted out the television set, causing the house to go up in flames.
Raleigh	7/17/1994	0/0	$87,785	Three house fires were caused by lightning.
N Raleigh	7/17/1995	0/0	$256,032	Lightning started a fire that destroyed a home.
RALEIGH	4/22/2006	0/0	$0	Numerous house fires reported throughout the county. At least four homes totally destroyed and 24 apartments in brier creek community destroyed.
RALEIGH	4/3/2006	0/0	$0	Lightning destroyed 3 apartment units.
RALEIGH	8/15/2008	0/0	$238,810	Two homes struck by lightning in the Raleigh caught fire resulting in extensive damage to each home.
Rolesville				
None reported				
Wake Forest				
WAKE FOREST	1/16/1998	0/0	$55,838	Lightning struck a brick house on Seawell Drive in Wake Forest about 20 miles northeast of Raleigh during the early afternoon. The lightning bolt hit the chimney of the new two story house, and the current ran throughout the house's wiring and into one of the bedrooms. Most of the damage was to the roof and in the bedroom. Flying debris and brick knocked holes in the walls, and bricks from the chimney were found 105 feet away in a neighbor's yard.
Wendell				
WENDELL	8/22/2003	0/0	$622,905	Lightning set fire to a home, destroying it.
Zebulon				
None reported				

	Date	Deaths/ Injuries	Property Damage*	Details

*Property damage is reported in 2013 dollars; All damages have not likely been reported.
Source: National Climatic Data Center

5.7.4 Probability of Future Occurrences

Although there were not a high number of historical lightning events reported throughout Wake County via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S. National Lightning Detection Network (NLDN®), Wake County is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the region.

5.7.5 Consequence Analysis

People (The Public and Public Confidence)

Although relatively rare when compared to other hazards, the impacts of lightning on people can be severe, resulting in death or severe injury if a person is struck. Fatalities and injuries from lightning events most often occur when a person is exposed and in outdoor conditions during a thunderstorm. Exposure to water and open areas also increases the likelihood that a person will be struck. Lightning generally has a low probability of impacting public confidence.

Responders

Although responders are generally aware of the effects of lightning and take precautions to avoid being impacted by a lightning strike, it is possible that they could be struck. Moreover, taking the necessary precautions to avoid a lightning strike can often reduce response times as staying inside and away from lightning is the best way to avoid injury from the hazard.

Continuity of Operations

Most critical facilities and infrastructure are protected against lightning via surge protectors and lightning rods. However, if lightning were to shut down large parts of the power grid due to blowing a transformer, operations would be detrimentally impacted. In general, however, continuity of operations during a lightning event would not be affected.

Built Environment (Property, Facilities, and Infrastructure)

Lightning generally does not have a major impact on property, facilities, or infrastructure. However, it has been known to affect power and energy sources through strikes which can shut down power for hours and sometimes days. Lightning is also responsible for igniting fires that can result in widespread damage to property.

Economy

Since lightning events generally pass through the area quickly and cause relatively little property damage when compared to other hazards, effects on the economy will likely be minimal. Nevertheless, if power-related infrastructure is damaged, this could cause some economic strain to replace and get the system back to full capacity.

Environment

The environmental effects of lightning are relatively minimal, although lightning has been known to cause wildfires which can lead to widespread damage. For more details on these impacts, please see this section of the wildfire hazard.

5.8 SEVERE THUNDERSTORM/HIGH WIND

5.8.1 Background

Thunderstorms can produce a variety of accompanying hazards including wind (discussed here), hail, and lightning.[9] Although thunderstorms generally affect a small area, they are very dangerous and may cause substantial property damage.

Three conditions need to occur for a thunderstorm to form. First, it needs moisture to form clouds and rain. Second, it needs unstable air, such as warm air that can rise rapidly (this often referred to as the "engine" of the storm). Third, thunderstorms need lift, which comes in the form of cold or warm fronts, sea breezes, mountains, or the sun's heat. When these conditions occur simultaneously, air masses of varying temperatures meet, and a thunderstorm is formed. These storm events can occur singularly, in lines, or in clusters. Furthermore, they can move through an area very quickly or linger for several hours.

According to the National Weather Service, more than 100,000 thunderstorms occur each year, though only about 10 percent of these storms are classified as "severe." A severe thunderstorm occurs when the storm produces at least one of these three elements: 1) hail of three-quarters of an inch, 2) a tornado, or 3) winds of at least 58 miles per hour.

Thunderstorm events have the capability of producing straight-line winds that can cause severe destruction to communities and threaten the safety of a population. Such wind events, sometimes separate from a thunderstorm event, are common in Wake County. Therefore, high winds are also reported in this section.

High winds can form due to pressure of the Northeast coast that combines with strong pressure moving through the Ohio Valley. This creates a tight pressure gradient across the region, resulting in high winds which increase with elevation. It is common for gusts of 30 to 60 miles per hour during the winter months.

Downbursts are also possible with thunderstorm events. Such events are a burst of wind in excess of 125 miles per hour. They are often confused with tornadoes. Downbursts are caused by down drafts from the base of a convective thunderstorm cloud. It occurs when rain-cooled air within the cloud becomes heavier than its surroundings. Thus, air rushes towards the ground in a destructive yet isolated manner. There are two types of downbursts. Downbursts less than 2.5 miles wide, duration less than 5 minutes, and winds up to 168 miles per hour are called "microbursts." Larger events greater than 2.5

[9]Lightning and hail hazards are discussed as separate hazards in this section.

miles at the surface and longer than 5 minutes with winds up to 130 miles per hour are referred to as "macrobursts."

5.8.2 Location and Spatial Extent

A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Also, Wake County typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Wake County has uniform exposure to a thunderstorm/wind event and the spatial extent of an impact could be large.

5.8.3 Historical Occurrences

Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011. According to NCDC, there have been 351 reported historic thunderstorm/high wind events in Wake County.[10] This includes data collected since 1994 for high wind and since 1950 for thunderstorms. These events caused over $1.2 million (2013 dollars) in damages. There were reports of six injuries and one fatality. **Table 5.24** summarize this information. **Table 5.25** present detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event. [11]

TABLE 5.24: SUMMARY OF HIGH WIND/THUNDERSTORM OCCURRENCES IN WAKE COUNTY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Apex	9	0/0	$51,338
Cary	18	0/0	$51,206
Fuquay-Varina	21	0/4	$467,105
Garner	11	0/0	$0
Holly Springs	13	0/0	$119,110
Knightdale	2	0/0	$1,126
Morrisville	5	0/0	$0
Raleigh	67	0/0	$164,787
Rolesville	9	0/0	$0
Wake Forest	5	0/0	$0
Wendell	1	0/0	$24,303
Zebulon	4	0/0	$40,283
Unincorporated Area	186	1/2	$323,146
WAKE COUNTY TOTAL	**351**	**1/6**	**$1,242,404**

Source: National Climatic Data Center

[10] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional thunderstorm events have occurred in Wake County. As additional local data becomes available, this hazard profile will be amended.
[11] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

Table 5.25: Historical High Wind/Thunderstorm Occurrences in Wake County

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Wake County					
Wake County	6/15/1958	TSTM WIND	0 kts.	0/0	$0
Wake County	6/15/1958	TSTM WIND	0 kts.	0/0	$0
Wake County	6/21/1964	TSTM WIND	50 kts.	0/0	$0
Wake County	10/7/1965	TSTM WIND	0 kts.	0/0	$0
Wake County	7/14/1966	TSTM WIND	0 kts.	0/0	$0
Wake County	7/20/1970	TSTM WIND	0 kts.	0/0	$0
Wake County	8/3/1970	TSTM WIND	0 kts.	0/0	$0
Wake County	5/17/1973	TSTM WIND	0 kts.	0/0	$0
Wake County	5/28/1973	TSTM WIND	0 kts.	0/0	$0
Wake County	8/12/1973	TSTM WIND	0 kts.	0/0	$0
Wake County	8/12/1973	TSTM WIND	0 kts.	0/0	$0
Wake County	6/23/1974	TSTM WIND	0 kts.	0/0	$0
Wake County	3/24/1975	TSTM WIND	0 kts.	0/0	$0
Wake County	3/24/1975	TSTM WIND	0 kts.	0/0	$0
Wake County	3/24/1975	TSTM WIND	0 kts.	0/0	$0
Wake County	10/9/1976	TSTM WIND	0 kts.	0/0	$0
Wake County	7/13/1977	TSTM WIND	0 kts.	0/0	$0
Wake County	2/11/1981	TSTM WIND	0 kts.	0/0	$0
Wake County	6/16/1982	TSTM WIND	0 kts.	0/0	$0
Wake County	7/3/1982	TSTM WIND	0 kts.	0/0	$0
Wake County	7/4/1982	TSTM WIND	0 kts.	0/0	$0
Wake County	8/23/1983	TSTM WIND	0 kts.	0/0	$0
Wake County	3/20/1984	TSTM WIND	52 kts.	0/0	$0
Wake County	3/20/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	3/21/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	3/21/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	4/4/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	5/8/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	5/8/1984	TSTM WIND	52 kts.	0/0	$0
Wake County	5/8/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	5/8/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	4/16/1985	TSTM WIND	0 kts.	0/0	$0
Wake County	5/22/1985	TSTM WIND	0 kts.	0/0	$0
Wake County	6/5/1985	TSTM WIND	0 kts.	0/0	$0
Wake County	6/5/1985	TSTM WIND	0 kts.	0/0	$0
Wake County	2/6/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	2/6/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	3/13/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	7/22/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	7/26/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	7/26/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	7/29/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	8/2/1986	TSTM WIND	53 kts.	0/0	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Wake County	8/2/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	8/10/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	8/11/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	4/12/1987	TSTM WIND	50 kts.	0/0	$0
Wake County	4/12/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	4/12/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	6/1/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	6/3/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	6/23/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	7/3/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	7/12/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	7/26/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	8/4/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	8/21/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	5/23/1988	TSTM WIND	0 kts.	0/0	$0
Wake County	6/17/1988	TSTM WIND	0 kts.	0/0	$0
Wake County	6/20/1988	TSTM WIND	0 kts.	0/0	$0
Wake County	6/20/1988	TSTM WIND	0 kts.	0/0	$0
Wake County	6/20/1988	TSTM WIND	0 kts.	0/0	$0
Wake County	7/31/1988	TSTM WIND	0 kts.	0/0	$0
Wake County	2/21/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	2/21/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	3/18/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	4/25/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	4/27/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	5/5/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	5/6/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	5/1/1990	TSTM WIND	0 kts.	0/0	$0
Wake County	6/22/1990	TSTM WIND	0 kts.	0/0	$0
Wake County	6/22/1990	TSTM WIND	0 kts.	0/0	$0
Wake County	6/22/1990	TSTM WIND	0 kts.	0/0	$0
Wake County	8/16/1990	TSTM WIND	0 kts.	0/0	$0
Wake County	4/8/1991	TSTM WIND	0 kts.	0/0	$0
Wake County	3/10/1992	TSTM WIND	0 kts.	0/0	$0
Wake County	3/10/1992	TSTM WIND	0 kts.	0/0	$0
Wake County	4/24/1992	TSTM WIND	0 kts.	0/0	$0
Wake County	8/12/1992	TSTM WIND	0 kts.	0/0	$0
Wake County	8/5/1994	THUNDERSTORM WINDS	0 kts.	0/0	$0
Wake County	5/19/1995	THUNDERSTORM WINDS	0 kts.	0/0	$68,275
Wake County	6/11/1995	THUNDERSTORM WINDS	60 kts.	0/0	$0
COUNTYWIDE	1/19/1996	TSTM WIND	0 kts.	0/0	$0
NEW HILL	4/15/1996	TSTM WIND	0 kts.	0/0	$16,574
SRN HALF	7/2/1996	TSTM WIND	0 kts.	0/0	$0
Wake County	4/1/1997	HIGH WIND	50 kts.	1/1	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Wake County	7/24/1997	HIGH WIND	50 kts.	0/0	$0
Wake County	2/3/1998	HIGH WIND	35 kts.	0/0	$0
Wake County	2/16/1998	HIGH WIND	52 kts.	0/0	$0
PURNELL	5/20/2000	TSTM WIND	50 kts.	0/0	$0
FALLS	8/10/2000	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	7/5/2002	TSTM WIND	50 kts.	0/0	$0
Wake County	3/7/2004	TSTM WIND	65 kts.	0/0	$7,030
Wake County	11/22/2006	HIGH WIND	38 kts.	0/0	$12,668
Wake County	4/16/2007	TSTM WIND	42 kts.	0/0	$0
Wake County	2/10/2008	TSTM WIND	43 kts.	0/0	$229
WILLIAMS XRDS	3/4/2008	TSTM WIND	61 kts.	0/0	$0
BAYLEAF	6/1/2008	TSTM WIND	50 kts.	0/0	$0
BAYLEAF	6/1/2008	TSTM WIND	50 kts.	0/0	$0
MILLBROOK	6/27/2008	TSTM WIND	50 kts.	0/0	$0
PURNELL	6/29/2008	TSTM WIND	50 kts.	0/0	$0
PURNELL	6/29/2008	TSTM WIND	50 kts.	0/0	$0
CARPENTER	7/4/2008	TSTM WIND	50 kts.	0/0	$0
PET XRDS	7/22/2008	STRONG WIND	50 kts.	0/0	$0
BAYLEAF	8/15/2008	THUNDERSTORM WIND	50 kts.	0/0	$17,911
BRENTWOOD	8/20/2008	STRONG WIND	50 kts.	0/0	$0
Wake County	9/6/2008	THUNDERSTORM WIND	50 kts.	0/0	$14,926
Wake County	9/6/2008	STRONG WIND	39 kts.	0/0	$7,463
Wake County	1/7/2009	THUNDERSTORM WIND	55 kts.	0/0	$115,927
UPCHURCH	5/5/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
BROOKHAVEN	5/9/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
COLLEGE VIEW	5/9/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
LEESVILLE	5/9/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
ROYAL MILLS	5/9/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
SIX FORKS	5/9/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
PURNELL	6/17/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
WILDERS GROVE	7/1/2009	THUNDERSTORM WIND	50 kts.	0/0	$2,319
WILLOW SPGS	7/27/2009	THUNDERSTORM WIND	60 kts.	0/0	$0
WILLOW SPGS	7/27/2009	HIGH WIND	50 kts.	0/0	$0
BAYLEAF	8/11/2009	STRONG WIND	50 kts.	0/0	$0
WESTOVER	8/17/2009	HIGH WIND	50 kts.	0/0	$0
PURNELL	9/28/2009	THUNDERSTORM	50 kts.	0/0	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
		WIND			
ROCKTON	6/13/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
LEESVILLE	7/20/2010	THUNDERSTORM WIND	57 kts.	0/0	$0
SIX FORKS	7/20/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
MILLBROOK	7/29/2010	THUNDERSTORM WIND	50 kts.	0/0	$1,126
CARALEIGH	8/5/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
WILDERS GROVE	8/5/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
PURNELL	8/23/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
FRIENDSHIP	11/16/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
AUBURN	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
BARHAM	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
COLLEGE VIEW	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
KENNEBEC	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
ROCKTON	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
WAKE XRDS	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
WILDERS GROVE	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
WILDERS GROVE	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
ROYAL MILLS	3/23/2011	THUNDERSTORM WIND	50 kts.	0/0	$21,855
BAYLEAF	6/10/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
ASBURY	6/20/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
BURT	6/21/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
MC CULLERS	6/27/2011	THUNDERSTORM WIND	54 kts.	0/0	$0
BONSAL	6/28/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
GREEN LEVEL	7/24/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
WILLIAMS XRDS	7/25/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
BROOKHAVEN	8/29/2011	THUNDERSTORM	50 kts.	0/0	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
		WIND			
WESTOVER	2/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
ASBURY	5/9/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
ASBURY	5/9/2012	THUNDERSTORM WIND	50 kts.	0/0	$2,122
MC CULLERS	5/9/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
ROYAL MILLS	5/23/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
WYATT	5/23/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
WAKE XRDS	6/1/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
PURNELL	6/29/2012	THUNDERSTORM WIND	50 kts.	0/0	$5,305
BARHAM	7/1/2012	THUNDERSTORM WIND	50 kts.	0/0	$1,061
BANKS	7/3/2012	THUNDERSTORM WIND	50 kts.	0/0	$2,122
CAMP POLK	7/3/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
MILLBROOK	7/3/2012	THUNDERSTORM WIND	50 kts.	0/0	$2,122
WILDERS GROVE	7/3/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
COLLEGE VIEW	7/4/2012	THUNDERSTORM WIND	50 kts.	0/0	$5,305
MILLBROOK	7/4/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
SIX FORKS	7/4/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
EAGLE ROCK	7/5/2012	THUNDERSTORM WIND	50 kts.	0/0	$3,183
MACEDONIA	7/5/2012	THUNDERSTORM WIND	50 kts.	0/0	$2,122
MILLBROOK	7/5/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
WILDERS GROVE	7/5/2012	THUNDERSTORM WIND	50 kts.	0/0	$3,183
MILLBROOK	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
ROCKTON	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
STARMOUNT	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
UPCHURCH	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
AUBURN	7/24/2012	THUNDERSTORM	50 kts.	0/0	$2,122

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
		WIND			
CAMP POLK	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
CAMP POLK	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
ECHO HGTS	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$2,122
LEESVILLE	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
METHOD	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$5,305
WILBON	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
CAMP POLK	7/28/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
FAWLERS XRDS	7/28/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
LEESVILLE	7/28/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
BAYLEAF	8/1/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
LASSITER	8/1/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
BAYLEAF	8/8/2012	THUNDERSTORM WIND	50 kts.	0/0	$769
ROCKTON	9/18/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
Apex					
Apex	8/3/1993	THUNDERSTORM WINDS	0 kts.	0/0	$9,008
APEX	7/14/2004	TSTM WIND	50 kts.	0/0	$0
APEX	7/19/2006	TSTM WIND	50 kts.	0/0	$0
APEX	4/5/2011	THUNDERSTORM WIND	50 kts.	0/0	$32,782
APEX	8/14/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
APEX	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
APEX	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$2,122
APEX	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
APEX	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$7,426
Cary					
Cary	8/3/1993	THUNDERSTORM WINDS	0 kts.	0/0	$0
Cary	8/3/1993	THUNDERSTORM WINDS	52 kts.	0/0	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Cary	3/21/1995	THUNDERSTORM WINDS	0 kts.	0/0	$51,206
CARY	6/4/1996	TSTM WIND	0 kts.	0/0	$0
CARY	6/30/1998	TSTM WIND	50 kts.	0/0	$0
CARY	8/18/2000	TSTM WIND	50 kts.	0/0	$0
CARY	8/19/2002	TSTM WIND	50 kts.	0/0	$0
CARY	8/19/2002	TSTM WIND	50 kts.	0/0	$0
CARY	1/14/2005	TSTM WIND	50 kts.	0/0	$0
CARY	3/8/2005	TSTM WIND	60 kts.	0/0	$0
CARY	4/17/2006	TSTM WIND	50 kts.	0/0	$0
CARY	4/22/2006	TSTM WIND	50 kts.	0/0	$0
CARY	8/9/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
CARY	8/21/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
CARY	3/4/2008	THUNDERSTORM WIND	51 kts.	0/0	$0
CARY	7/28/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
CARY	7/30/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
CARY	7/24/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
Cary	8/3/1993	THUNDERSTORM WINDS	0 kts.	0/0	$0
Cary	8/3/1993	THUNDERSTORM WINDS	52 kts.	0/0	$0
Cary	3/21/1995	THUNDERSTORM WINDS	0 kts.	0/0	$51,206
CARY	6/4/1996	TSTM WIND	0 kts.	0/0	$0
CARY	6/30/1998	TSTM WIND	50 kts.	0/0	$0
CARY	8/18/2000	TSTM WIND	50 kts.	0/0	$0
CARY	8/19/2002	TSTM WIND	50 kts.	0/0	$0
CARY	8/19/2002	TSTM WIND	50 kts.	0/0	$0
CARY	1/14/2005	TSTM WIND	50 kts.	0/0	$0
CARY	3/8/2005	TSTM WIND	60 kts.	0/0	$0
CARY	4/17/2006	TSTM WIND	50 kts.	0/0	$0
CARY	4/22/2006	TSTM WIND	50 kts.	0/0	$0
CARY	8/9/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
CARY	8/21/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
CARY	3/4/2008	THUNDERSTORM WIND	51 kts.	0/0	$0
CARY	7/28/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
CARY	7/30/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
CARY	7/24/2011	THUNDERSTORM	50 kts.	0/0	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
		WIND			
Fuquay-Varina					
Fuquay-Varina	1/7/1995	THUNDERSTORM WINDS	0 kts.	0/4	$426,721
FUQUAY SPGS	4/19/1998	TSTM WIND	50 kts.	0/0	$39,884
FUQUAY SPGS	7/7/2005	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	4/17/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	4/22/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	4/22/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	4/22/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	5/14/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	5/14/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	5/14/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	6/11/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	3/2/2007	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	6/29/2007	THUNDERSTORM WIND	54 kts.	0/0	$0
VARINA	8/21/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
VARINA	9/14/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
VARINA	9/14/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
VARINA	9/14/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
VARINA	9/14/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
VARINA	7/23/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
VARINA	7/9/2012	THUNDERSTORM WIND	50 kts.	0/0	$530
Garner					
GARNER	3/3/1999	TSTM WIND	50 kts.	0/0	$0
GARNER	7/12/2004	TSTM WIND	50 kts.	0/0	$0
GARNER	7/28/2005	TSTM WIND	52 kts.	0/0	$0
GARNER	4/17/2006	TSTM WIND	50 kts.	0/0	$0
GARNER	4/25/2006	TSTM WIND	54 kts.	0/0	$0
GARNER	6/11/2006	TSTM WIND	56 kts.	0/0	$0
GARNER	7/29/2006	TSTM WIND	50 kts.	0/0	$0
GARNER	4/15/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
GARNER	8/21/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
GARNER	8/21/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
GARNER	5/9/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
Holly Springs					

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Holly Springs	8/17/1994	THUNDERSTORM WINDS	56 kts.	0/0	$0
HOLLY SPGS	6/3/1998	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	3/3/1999	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	5/13/2002	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	4/25/2006	TSTM WIND	51 kts.	0/0	$0
HOLLY SPGS	4/25/2006	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	4/25/2006	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	4/25/2006	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	6/11/2006	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	7/11/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
HOLLY SPGS	7/31/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
HOLLY SPGS	7/31/2009	THUNDERSTORM WIND	50 kts.	0/0	$115,927
HOLLY SPGS	7/9/2012	THUNDERSTORM WIND	50 kts.	0/0	$3,183
Knightdale					
KNIGHTDALE	6/13/2010	THUNDERSTORM WIND	50 kts.	0/0	$1,126
KNIGHTDALE	4/5/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
Morrisville					
MORRISVILLE	5/6/1996	TSTM WIND	0 kts.	0/0	$0
MORRISVILLE	4/17/2000	TSTM WIND	50 kts.	0/0	$0
MORRISVILLE	6/7/2005	TSTM WIND	50 kts.	0/0	$0
MORRISVILLE	8/30/2008	THUNDERSTORM WIND	50 kts.	0/0	$0
MORRISVILLE	7/23/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
Raleigh					
Raleigh	8/17/1993	THUNDERSTORM WINDS	0 kts.	0/0	$0
Raleigh	7/17/1994	THUNDERSTORM WINDS	0 kts.	0/0	$0
NW Raleigh	7/18/1994	THUNDERSTORM WINDS	61 kts.	0/0	$0
RDU Airport	8/5/1994	THUNDERSTORM WIND	0 kts.	0/0	$0
N Raleigh	11/11/1995	THUNDERSTORM WINDS	0 kts.	0/0	$20,483
W Raleigh	11/11/1995	THUNDERSTORM WINDS	0 kts.	0/0	$0
RALEIGH	4/23/1996	TSTM WIND	0 kts.	0/0	$0
RALEIGH-DURHAM ARPT	5/11/1996	TSTM WIND	55 kts.	0/0	$82,869
RALEIGH	8/22/1996	TSTM WIND	50 kts.	0/0	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
RALEIGH	11/8/1996	TSTM WIND	50 kts.	0/0	$0
RDU AIRPORT	2/21/1997	TSTM WIND	56 kts.	0/0	$0
RALEIGH	5/1/1997	TSTM WIND	50 kts.	0/0	$48,606
RALEIGH	6/15/1998	TSTM WIND	50 kts.	0/0	$0
RALEIGH	8/16/1998	TSTM WIND	50 kts.	0/0	$0
RALEIGH	8/14/1999	TSTM WIND	0 kts.	0/0	$0
RALEIGH	4/8/2000	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2000	TSTM WIND	60 kts.	0/0	$0
RALEIGH	8/18/2000	TSTM WIND	50 kts.	0/0	$0
RALEIGH	3/26/2002	TSTM WIND	50 kts.	0/0	$0
RALEIGH	8/24/2002	TSTM WIND	50 kts.	0/0	$0
RALEIGH	7/10/2003	TSTM WIND	50 kts.	0/0	$0
RALEIGH	3/7/2004	TSTM WIND	60 kts.	0/0	$0
RALEIGH	6/11/2004	TSTM WIND	50 kts.	0/0	$0
RALEIGH	7/29/2004	TSTM WIND	60 kts.	0/0	$0
RALEIGH	8/13/2004	TSTM WIND	50 kts.	0/0	$0
RALEIGH	9/17/2004	TSTM WIND	50 kts.	0/0	$0
RALEIGH DURHAM ARPT	9/17/2004	TSTM WIND	69 kts.	0/0	$0
RALEIGH	6/7/2005	TSTM WIND	50 kts.	0/0	$0
RALEIGH	7/28/2005	TSTM WIND	50 kts.	0/0	$0
RALEIGH	4/3/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	4/22/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	4/22/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/26/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/26/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	6/23/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	7/27/2006	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	11/16/2006	THUNDERSTORM WIND	52 kts.	0/0	$0
RALEIGH DURHAM ARPT	3/2/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	6/9/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/17/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/17/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/17/2007	THUNDERSTORM	51 kts.	0/0	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
		WIND			
RALEIGH	7/17/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	8/10/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	8/21/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	8/21/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	3/4/2008	THUNDERSTORM WIND	61 kts.	0/0	$0
RALEIGH	7/6/2008	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/1/2009	THUNDERSTORM WIND	50 kts.	0/0	$1,159
RALEIGH	7/17/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/17/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/17/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	9/28/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/3/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/4/2012	THUNDERSTORM WIND	50 kts.	0/0	$1,061
RALEIGH	7/23/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$10,609
(RDU)RALEIGH-DURHAM	7/28/2012	THUNDERSTORM WIND	57 kts.	0/0	$0
Rolesville					
ROLESVILLE	5/1/1997	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	8/18/2000	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	11/11/2002	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	4/3/2006	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	5/14/2006	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	6/23/2006	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	7/27/2006	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	7/11/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
ROLESVILLE	8/21/2011	THUNDERSTORM WIND	50 kts.	0/0	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Wake Forest					
WAKE FOREST	1/19/1996	TSTM WIND	0 kts.	0/0	$0
WAKE FOREST/ZEBULON	3/5/1997	TSTM WIND	50 kts.	0/0	$0
WAKE FOREST	8/14/1999	TSTM WIND	0 kts.	0/0	$0
WAKE FOREST	6/11/2004	TSTM WIND	50 kts.	0/0	$0
WAKE FOREST	7/1/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
Wendell					
WENDELL	5/1/1997	TSTM WIND	50 kts.	0/0	$24,303
Zebulon					
ZEBULON	5/1/1997	TSTM WIND	50 kts.	0/0	$32,404
ZEBULON	6/2/1997	TSTM WIND	50 kts.	0/0	$0
ZEBULON	3/8/2005	TSTM WIND	50 kts.	0/0	$0
ZEBULON	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$7,879

5.8.4 Probability of Future Occurrences

Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire planning area.

5.8.5 Consequence Analysis

People (The Public and Public Confidence)

Thunderstorms are generally associated with several other hazards such as high wind and flooding, the latter of which is caused by torrential rain. As such, the public could be impacted in a number of ways by a thunderstorm event. High wind can cause trees to fall and potentially result in injuries or death and rising floodwaters can lead to drowning or other serious injury. Although often not as severe as hurricanes or tornadoes, the impacts on the public from thunderstorms can be significant. However, the public confidence is usually not affected to a large degree as a result of thunderstorms.

Responders

Responders are not generally affected to any great degree by thunderstorm events, although it should be noted that they could be impacted in many of the same ways as the public. Otherwise, responders could be affected by road blockages caused by downed trees or floodwaters, which would ultimately reduce their response time.

Continuity of Operations

In general, continuity of operations during a thunderstorm event can be maintained. Thunderstorm events often affect power in much the same way as tornadoes and hurricanes, which ultimately may impact operations. However, thunderstorm events are typically not large enough and their impacts are not wide enough to disrupt continuity of operations in Wake County.

Built Environment (Property, Facilities, and Infrastructure)

Thunderstorms often have their greatest impact on the built environment as they can cause damage to homes via strong winds or flooding and will often impact facilities and infrastructure in the same way. Power losses often occur due to damage to power lines and roads can flood and cause damage as well. In fact, thunderstorms are often considered one of the greater hazards of concern even though any given event will cause relatively little damage, because damaging events occur so frequently.

Economy

Economic impacts from thunderstorm events can often be far reaching as the damage from these events are often widespread, affecting both homes and businesses. This damage can result in business and economic disruption through the recovery process.

Environment

Thunderstorms can impact crops via high wind and flooding and can also impact the natural environment through these elements. Flooding can kill plants and animals as well as contaminate drinking water supplies for human populations. High wind can harm forests by bringing down trees and cause fires from downed power lines that impact the environment.

5.9 TORNADO

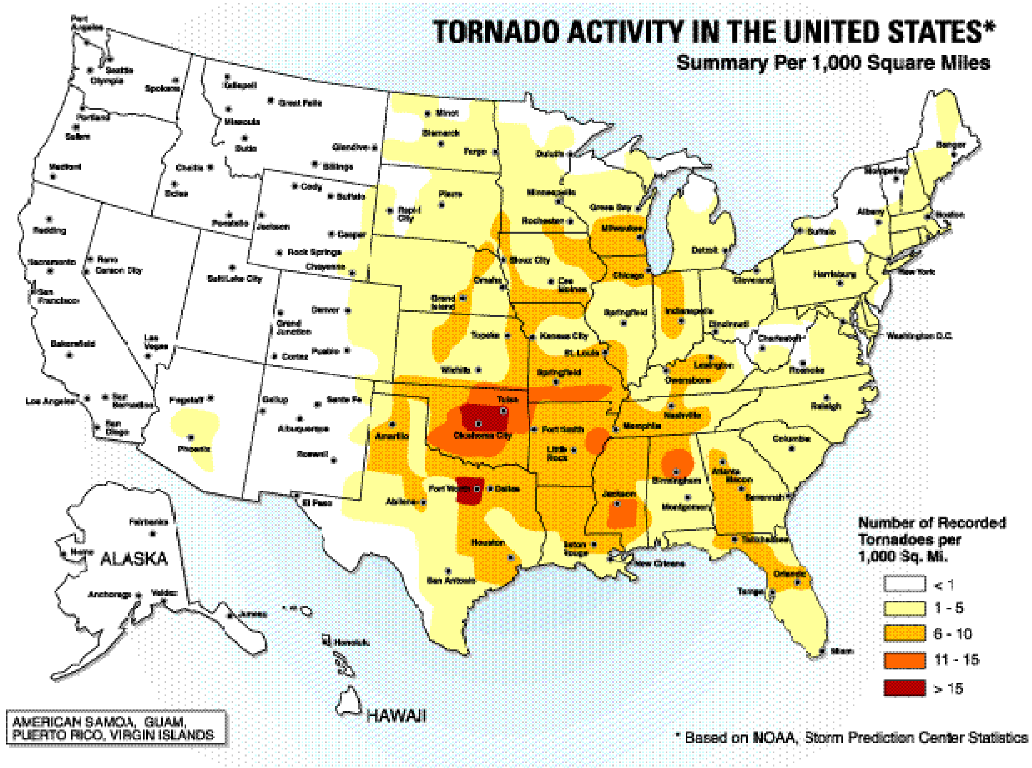
5.9.1 Background

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity (but sometimes result from hurricanes and other tropical storms) when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of the high wind velocity and wind-blown debris, also accompanied by lightning or large hail. According to the National Weather Service, tornado wind speeds normally range from 40 miles per hour to more than 300 miles per hour. The most violent tornadoes have rotating winds of 250 miles per hour or more and are capable of causing extreme destruction and turning normally harmless objects into deadly missiles.

Each year, an average of over 800 tornadoes is reported nationwide, resulting in an average of 80 deaths and 1,500 injuries.[12] According to the NOAA Storm Prediction Center (SPC), the highest concentration of tornadoes in the United States has been in Oklahoma, Texas, Kansas, and Florida respectively. Although the Great Plains region of the Central United States does favor the development of the largest and most dangerous tornadoes (earning the designation of "tornado alley"), Florida experiences the greatest number of tornadoes per square mile of all U.S. states (SPC, 2002). **Figure 5.6** shows tornado activity in the United States based on the number of recorded tornadoes per 1,000 square miles.

[12] NOAA, 2009.

FIGURE 5.6: TORNADO ACTIVITY IN THE UNITED STATES



Source: Federal Emergency Management Agency

Tornadoes are more likely to occur during the months of March through May and are most likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touch down briefly, but even small short-lived tornadoes can inflict tremendous damage. Highly destructive tornadoes may carve out a path over a mile wide and several miles long.

The destruction caused by tornadoes ranges from light to inconceivable depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light construction, including residential dwellings (particularly mobile homes). Tornadic magnitude is reported according to the Fujita and Enhanced Fujita Scales. Tornado magnitudes prior to 2005 were determined using the traditional version of the Fujita Scale (**Table 5.26**). Tornado magnitudes that were determined in 2005 and later were determined using the Enhanced Fujita Scale (**Table 5.27**).

TABLE 5.26: THE FUJITA SCALE (EFFECTIVE PRIOR TO 2005)

F-SCALE NUMBER	INTENSITY	WIND SPEED	TYPE OF DAMAGE DONE
F0	GALE TORNADO	40–72 MPH	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
F1	MODERATE TORNADO	73–112 MPH	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	SIGNIFICANT TORNADO	113–157 MPH	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	SEVERE TORNADO	158–206 MPH	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
F4	DEVASTATING TORNADO	207–260 MPH	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	INCREDIBLE TORNADO	261–318 MPH	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-enforced concrete structures badly damaged.
F6	INCONCEIVABLE TORNADO	319–379 MPH	These winds are very unlikely. The small area of damage they might produce would probably not be recognizable along with the mess produced by F4 and F5 wind that would surround the F6 winds. Missiles, such as cars and refrigerators would do serious secondary damage that could not be directly identified as F6 damage. If this level is ever achieved, evidence for it might only be found in some manner of ground swirl pattern, for it may never be identifiable through engineering studies.

Source: National Weather Service

TABLE 5.27 THE ENHANCED FUJITA SCALE (EFFECTIVE 2005 AND LATER)

EF-SCALE NUMBER	INTENSITY PHRASE	3 SECOND GUST (MPH)	TYPE OF DAMAGE DONE
F0	GALE	65–85	Some damage to chimneys; breaks branches off trees; pushes over shallow-rooted trees; damages to sign boards.
F1	MODERATE	86–110	The lower limit is the beginning of hurricane wind speed; peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos pushed off the roads; attached garages may be destroyed.
F2	SIGNIFICANT	111–135	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars pushed over; large trees snapped or uprooted; light object missiles generated.
F3	SEVERE	136–165	Roof and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted.
F4	DEVASTATING	166–200	Well-constructed houses leveled; structures with weak foundations blown off some distance; cars thrown and large missiles generated.
F5	INCREDIBLE	Over 200	Strong frame houses lifted off foundations and carried considerable distances to disintegrate; automobile sized missiles fly through the air in excess of 100 meters; trees debarked; steel re-enforced concrete structures badly damaged.

Source: National Weather Service

5.9.2 Location and Spatial Extent

Tornadoes occur throughout the state of North Carolina, and thus in Wake County. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is difficult to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that all of Wake County is uniformly exposed to this hazard.

5.9.3 Historical Occurrences

Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there have been a total of thirty-three recorded tornado events in Wake County since 1956 (**Table 5.28**), resulting in over $700 million (2013 dollars) in property damages.[13] In addition, 7 deaths and 213 injuries were reported (**Table 5.29**). The magnitude of these tornadoes ranges from F0 to F4 in intensity, although an F5 event is possible. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is likely that a high number of occurrences have gone unreported over the past 63 years.

[13] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Wake County. As additional local data becomes available, this hazard profile will be amended.

TABLE 5.28: SUMMARY OF TORNADO OCCURRENCES IN WAKE COUNTY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Apex	1	0/0	$0
Cary	2	0/0	$82,869
Fuquay-Varina	0	0/0	$0
Garner	2	0/2	$1,036,983
Holly Springs	1	0/0	$0
Knightdale	0	0/0	$0
Morrisville	0	0/0	$0
Raleigh	2	0/0	$23,930
Rolesville	1	0/1	$109,273
Wake Forest	0	0/0	$0
Wendell	2	0/26	$4,988,724
Zebulon	1	0/0	$0
Unincorporated Area	21	7/184	$700,021,569
WAKE COUNTY TOTAL	**33**	**7/213**	**$706,263,348**

Source: National Climatic Data Center

TABLE 5.29: HISTORICAL TORNADO IMPACTS IN WAKE COUNTY

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Wake County					
Wake County	5/12/1950	F0	0/0	$0	
Wake County	5/12/1950	F1	0/0	$0	
Wake County	4/5/1952	F2	0/0	$245,175	
Wake County	3/18/1956	F1	0/1	$239,506	
Wake County	3/18/1956	F2	0/0	$23,951	
Wake County	11/2/1966	F2	0/9	$2,011,388	
Wake County	5/14/1967	F0	0/0	$0	
Wake County	7/11/1967	F1	0/0	$194,529	
Wake County	5/28/1973	F1	0/0	$146,412	
Wake County	5/29/1973	F0	0/0	$146,412	
Wake County	12/31/1975	F1	0/0	$12,080	
Wake County	5/7/1977	F0	0/0	$10,734	
Wake County	2/11/1981	F2	0/2	$715,623	
Wake County	6/13/1982	F1	1/0	$67,373	
Wake County	6/16/1982	F2	0/0	$673,733	
Wake County	3/14/1986	F1	0/0	$59,362	
Wake County	3/26/1988	F0	2/105		
Wake County	11/28/1988	F4	0/0	$569,530,309	
Wake County	10/23/1990	F1	0/0	$0	
ROCKTON	4/25/2010	F0	0/0	$281,377	EPISODE NARRATIVE: An isolated cell formed over Moore County in advance of a strong surface cold front in a high shear and moderate CAPE environment. The lone storm strengthened into a super cell over

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
					central Wake County before it produced a weak EF0 tornado near Zebulon in eastern Wake County.
BURT	4/16/2011	F3	4/67	$125,663,605	EPISODE NARRATIVE: A strong storm system that had a history of producing deadly tornadoes across Oklahoma and the deep south on the 14th and 15th weakened as it crossed the southern Appalachians during the early morning hours of the 16th. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries
Apex					
Apex	9/27/2004	F0	0/0	$0	A tornado touched down near the intersection of Holly Springs Road and Kildaire Farm Road. Minor property damage occurred to a few mobile homes, and a few trees and power lines were blown down. The tornado lifted briefly, and then touched down again on the north side of Apex were several large trees were blown down, especially near the intersection of Schiefflin Road and James road, and along Culvert Street.
Cary					
Cary	7/12/1996	F0	0/0	$82,869	A small tornado formed along an outer band of Hurricane Bertha. The hurricane was centered approximately 140 miles to the southeast. The tornado was on the ground about 6 minutes and moved east to west at 50 mph. Numerous trees were snapped or uprooted. About 10 homes received minor damage due to falling trees.
Cary	6/1/2001	F0	0/0	$0	Siding was blown off of apartment buildings near Highway 54 and Cary Parkway. Trees were also blown down in the area, and a funnel cloud was reported.

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Fuquay-Varina					
None reported					
Garner					
Garner	3/20/1998	F2	0/2	$1,036,983	The tornado remained a funnel as it roared over the Greenbrier Estates just east of US401. Trees were sporadically uprooted and snapped off. Several trees fell on homes and outbuildings. The tornado touched down on Highway 70 at a church. The roof of one section was taken off and the steeple was blown off the chapel. The debris from the church took out windows at a car lot across the street. A block way, the wind removed several large siding sheets from a business
Garner	9/14/2007	F0	0/0	$0	EVENT NARRATIVE: Public reported a brief touch down of a tornado with debris just south of Garner near Lake Benson.
Holly Springs					
Holly Springs	3/20/1998	F0	0/0	$0	A home video of this storm showed a wall cloud with several small vortices. One of these touched down very briefly and damaged the roof of one home. The adjacent homes, and there were many, were untouched. The insulation from the home was then spread into adjacent trees
Knightdale					
None reported					
Morrisville					
None reported					
Raleigh					
Raleigh	3/27/1993	F0	0/0	$0	A small tornado touched down briefly south of Lake Wheeler and moved northward blowing down trees in its path.
Raleigh	3/20/1998	F0	0/0	$23,930	The storm that hit Garner produced another tornado 6 miles to the northeast on the east side of Raleigh. Damage began just off US64 at Wake Medical Center and the Tower Shopping Center. Cars were overturned, trees were damaged, and a steel-beamed billboard was twisted. The tornado then crossed the highway where it lifted the roof off the business office of a tree nursey, damaged two sheds, and

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
					destroyed 5 greenhouses. Insulation and debris was strewn up in the trees well away from the path.
Rolesville					
ROLESVILLE	3/6/2011	F0	0/1	$109,273	EPISODE NARRATIVE: Convection developed along and ahead of a cold front that moved across the state during the late afternoon and early evening hours. Two weak EF0 tornadoes developed across central North Carolina when discrete cells along a couple of mesolows merged with the main convective band.
Wake Forest					
None reported					
Wendell					
Wendell	4/15/1996	F1	0/26	$4,972,150	The second is a series of three tornadoes began about 100 yards to the SE of where the first tornado began (off Hwy 64 in Wendell). The storm was initially less than 25 yards wide asit moved NNE and twisted trees and blew shingles off several houses. About one half mile from the initial touchdown, the storm widened to 50 yards as it approached the town of Zebulon. Trees were downed and the roof was blown off a brick home near the railroad tracks. Another home and a manufactured home were damaged as the storm crossed a street and moved up a hill. The storm then preceded over and down the hill into a mobile home park. Damage was extensive to all the trailers in the park that were directly in the path. The storm continued moving NNE into downtown Zebulon where it downed numerous large trees. Houses in the direct path of the storm were all brick and sustained only roof damage. The Zebulon Middle School sustained major roof damage to the main building. The tornado was last noted at Karial and Old Bunn Roads where minor damage occurred to a frame house and severel trees were twisted
Wendell	4/15/1996	F0	0/0	$16,574	An F0 tornado initially touched down off Hwy 64 in Wendell. The tornado width was initially only 50 feet where several trees were taken down. The tornado increased in width to 200

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
					yards as it paralleled Hwy 64 and moved into the west side of the town of Zebulon. The storm damaged the Courtesy Car Dealership and tossed a showroom car across the highway. Numerous trees were twisted and felled. The tornado then crossed the highway and narrowed significantly as it reached Hwy 96 and Greenspeace Road about 0.3 miles west of the Wakefield community where it lifted.
Zebulon					
ZEBULON	9/18/2012	F0	0/0	$0	EPISODE NARRATIVE: Multiple line segments of strong to severe storms developed over North Carolina as a compact but potent shortwave emanating from the gulf coast region and along the eastern flanks of a full latitude trough moved through the Carolinas. The accompanying 50 to 60 knot mid level jet within a moist and unstable air mass produced scattered thunderstorm wind damage and an isolated EF-0 tornado near Zebulon.

*Property Damage is reported in 2013 dollars.
Source: NCDC

5.9.4 Probability of Future Occurrences

According to historical information, tornado events are not an annual occurrence for the county. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Wake County experience a direct tornado strike. The probability of future tornado occurrences affecting Wake County is likely (10-100 percent annual probability).

5.9.5 Consequence Analysis

People (The Public and Public Confidence)

The entire Wake County population is vulnerable to the impacts of a tornado regardless of the measured magnitude. Because it cannot be predicted where a tornado will touch down, it cannot be said which areas of the population within the county are most vulnerable. However, injuries as well as deaths resulting from tornadoes are the most significant impacts. Tornadoes often have a high likelihood of affecting public confidence due to their destructive and highly visible impacts.

Responders

Responders could be critically affected by tornado events as the onset is often very rapid and unpredictable, thereby putting response personnel potentially in harm's way. Due to the unpredictability of such events, response may also be hindered as responders may be unable to access those that have been affected if storm conditions persist and they are unable to safely enter affected areas.

Continuity of Operations

Continuity of operations could be greatly impacted by a tornado as personnel may be harmed and critical resources damaged or destroyed during a tornado. In many ways, since the impacts of a tornado are unpredictable, it is also difficult to predict and plan for the appropriate ways to ensure a continuity of operations. Although Wake County is well prepared for such an event, disruption of operations will likely take place to some degree.

Built Environment (Property, Facilities, and Infrastructure)

Building Inventory

Wake County has been impacted by tornadoes ranging in intensity from F0 through F4 based on the Fujita and Enhanced-Fujita scales. Because it cannot be predicted where a tornado may touch down, all buildings and facilities within the county are considered exposed to the hazard and at risk for being impacted. **Table 5.30** lists the number of buildings by type of structure in Wake County—according to the 2010 U.S. Census—at risk for being impacted by a tornado.

TABLE 5.30 WAKE COUNTY BUILDINGS BY TYPE (2010)

Building Type	Total Number of Buildings	Percentage of Total
Residential	218,598	90.34%
Commercial	15,526	6.42%
Industrial	4,432	1.83%
Agriculture	1,048	.43%
Religion	1,336	.55%
Government	488	.20%
Education	545	.23%
Total	241,973	

Wind

Building materials play a role in how well a structure can withstand tornado force winds. **Table 5.31** shows the percentage of buildings by type within Wake County. Buildings that use structural steel, reinforced concrete, or load-bearing masonry have the best chance of withstanding a tornado event in the county. Homes constructed of wood or manufactured material are most at risk. Non-engineered structures in the county are far more vulnerable than engineered buildings to damage from tornado winds.

TABLE 5.31 WAKE COUNTY BUILDINGS BY MATERIAL TYPE

Building Material	Total Number of Buildings	Percentage of Total
Manufactured Concrete	29,853	12.33%
Manufactured	13,934	5.76%

Building Material	Total Number of Buildings	Percentage of Total
Masonry	10,997	4.54%
Steel	2,491	1.03%
Wood	183,668	75.9%
Other	1,030	.427%
Total	241,973	

Critical Facilities and Key Resources

All critical facilities and key resources are equally vulnerable to the impacts of a tornado. The magnitude of the tornado will determine the extent of damage and impacts that are felt throughout the county. These impacts can include structural failure, debris damage, and loss of facility functionality.

Critical Infrastructure

The county's infrastructure system is equally vulnerable to the impacts of a tornado. This includes critical infrastructure such as roads, railroads, bridges, utilities (power and gas), and pipelines. Any number of these infrastructure systems could be damaged in the event of a tornado. Impacts could include structural damage, impassable or blocked roadways, failed utility lines, railway failure, and impassable bridges.

Key Resources

The county's key resources are equally vulnerable to the impacts of a tornado. Any number of key resources could be damaged or lost in the event of a tornado. Impacts could include structural damage, and loss of power and utilities.

Economy

A tornado can impact any area of Wake County at any time and brings with it significant property and crop damage costs. **Table 5.32** shows a breakdown of the costs incurred from tornadoes that have impacted Wake County between 1950 and 2010.

TABLE 5.32 WAKE COUNTY PROPERTY AND CROP DAMAGE COSTS

Time Period	Property Damage	Crop Damage
1950–1960	$53,000	$0
1961–1970	$275,000	$0
1971–1980	$56,000	$0
1981–1990	$250,000,000	$0
1991–2000	$6,715,000	$0
2001–2010	$350,000	$25,000

Environment

Downed trees, power lines, and other forms of vegetation and building material can block roadways, cover residential areas, and cause property and building damage. Coordinated countywide cleanup efforts after a tornado can include removal of debris. Multi-material facilities may be available for debris drop-off for residents. Debris cleanup may be part of individual insurance policies.

5.10 WINTER STORM AND FREEZE

5.10.1 Background

A winter storm can range from a moderate snow over a period of a few hours to blizzard conditions with blinding wind-driven snow that lasts for several days. Events may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. Some winter storms might be large enough to affect several states, while others might affect only localized areas. Occasionally, heavy snow might also cause significant property damages, such as roof collapses on older buildings.

All winter storm events have the potential to present dangerous conditions to the affected area. Larger snowfalls pose a greater risk, reducing visibility due to blowing snow and making driving conditions treacherous. A heavy snow event is defined by the National Weather Service as an accumulation of 4 of more inches in 12 hours or less. A blizzard is the most severe form of winter storm. It combines low temperatures, heavy snow, and winds of 35 miles per hour or more, which reduces visibility to a quarter mile or less for at least 3 hours. Winter storms are often accompanied by sleet, freezing rain, or an ice storm. Such freeze events are particularly hazardous as they create treacherous surfaces.

Ice storms are defined as storms with significant amounts of freezing rain and are a result of cold air damming (CAD). 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 super-cooled (liquid below the melting point of water) or re-freezes. In the former case, super-cooled droplets can freeze on impact (freezing rain), while in the latter case, the re-frozen water particles are ice pellets (or sleet). Sleet is defined as partially frozen raindrops or refrozen snowflakes that form into small ice pellets before reaching the ground. They typically bounce when they hit the ground and do not stick to the surface. However, it does accumulate like snow, posing similar problems and has the potential to accumulate into a layer of ice on surfaces. Freezing rain, conversely, usually sticks to the ground, creating a sheet of ice on the roadways and other surfaces. All of the winter storm elements – snow, low temperatures, sleet, ice, etcetera – have the potential to cause significant hazard to a community. Even small accumulations can down power lines and trees limbs and create hazardous driving conditions. Furthermore, communication and power may be disrupted for days.

5.10.2 Location and Spatial Extent

Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Wake County is accustomed to smaller scale severe winter weather conditions and often receives winter weather during the winter months. Given the atmospheric nature of the hazard, the entire region has uniform exposure to a winter storm.

5.10.3 Historical Occurrences

Winter weather has resulted in six disaster declarations in Wake County. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. According to the National Climatic Data Center, there have been a total of 30 recorded winter storm events in Wake County since 1993 (**Table 5.33**).[14] These events resulted in over $900,000 (2013 dollars) in damages. Those events with reported damages and fatalities are presented in **Table 5.34**.[15]

TABLE 5.33: SUMMARY OF WINTER STORM EVENTS IN WAKE COUNTY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Apex	0	0/0	$0
Cary	0	0/0	$0
Fuquay-Varina	0	0/0	$0
Garner	0	0/0	$0
Holly Springs	0	0/0	$0
Knightdale	0	0/0	$0
Morrisville	0	0/0	$0
Raleigh	0	0/0	$0
Rolesville	0	0/0	$0
Wake Forest	0	0/0	$0
Wendell	0	0/0	$0
Zebulon	0	0/0	$0
Unincorporated Area	30	2/10*	$900,752
WAKE COUNTY TOTAL	**30**	**2/10***	**$900,752**

*These fatalities/injuries were the result of a statewide event and NCDC did not indicate in which county they occurred. Therefore, these may not have occurred in Wake County, but were caused by an event that impacted the county.

Source: National Climatic Data Center

TABLE 5.34: HISTORICAL WINTER STORM IMPACTS IN WAKE COUNTY

	Date	Type of Storm	Deaths/Injuries	Property Damage*
Wake County				
Statewide	3/12/1993	WINTER STORM	2/10	$900,752
Northern and Central	1/3/1994	HEAVY SNOW	0/0	$0
Northern Interior	2/10/1994	ICE STORM	0/0	$0
Wake County	1/6/1996	WINTER STORM	0/0	$0
Wake County	1/11/1996	ICE STORM	0/0	$0
Wake County	2/2/1996	ICE STORM	0/0	$0
Wake County	2/16/1996	HEAVY SNOW	0/0	$0
Wake County	1/19/1998	HEAVY SNOW	0/0	$0
Wake County	12/23/1998	ICE STORM	0/0	$0
Wake County	1/18/2000	WINTER STORM	0/0	$0

[14] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional winter storm conditions have affected Wake County.

[15] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

	Date	Type of Storm	Deaths/Injuries	Property Damage*
Wake County	1/20/2000	WINTER STORM	0/0	$0
Wake County	1/22/2000	WINTER STORM	0/0	$0
Wake County	1/24/2000	WINTER STORM	0/0	$0
Wake County	1/28/2000	WINTER STORM	0/0	$0
Wake County	11/19/2000	HEAVY SNOW	0/0	$0
Wake County	1/3/2002	WINTER STORM	0/0	$0
Wake County	12/4/2002	WINTER STORM	0/0	$0
Wake County	2/16/2003	WINTER STORM	0/0	$0
Wake County	2/27/2003	WINTER STORM	0/0	$0
Wake County	1/26/2004	WINTER STORM	0/0	$0
Wake County	2/15/2004	WINTER STORM	0/0	$0
Wake County	2/26/2004	WINTER STORM	0/0	$0
Wake County	12/26/2004	WINTER STORM	0/0	$0
Wake County	1/18/2007	WINTER WEATHER	0/0	$0
Wake County	2/1/2007	WINTER WEATHER	0/0	$0
Wake County	2/1/2007	WINTER STORM	0/0	$0
Wake County	1/17/2008	WINTER WEATHER	0/0	$0
Wake County	12/25/2010	WINTER STORM	0/0	$0
Wake County	1/28/2014	WINTER STORM	0/0	$0
Wake County	2/12/2014	WINTER STORM	0/0	$0

There have been several severe winter weather events in the Wake County. The text below describes one of the major events and associated impacts on the county. Similar impacts can be expected with severe winter weather.

1996 Winter Storm
This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and power outages. Furthermore, citizens may resort to using inappropriate heating devices that could to fire or an accumulation of toxic fumes.

5.10.4 Probability of Future Occurrences

Winter storm events will remain a somewhat regular occurrence in Wake County due to its location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

5.10.5 Consequence Analysis

People (The Public and Public Confidence)
Winter storms most often impact people indirectly. Winter storms can create dangerous driving conditions by limiting visibility for drivers or creating slick conditions that make maneuverability difficult.

Loss of power can create very cold conditions for residents, making it difficult to stay warm. Residents may try to heat their home using alternative means, which runs the risk of carbon monoxide poisoning caused by improperly ventilated heating sources. In addition, dangerously cold temperatures increase the risk of wind chill, frostbite, and hypothermia. Winter storms generally do not have a large impact on public confidence, but it could be impacted if road clearing or response operations are slow.

Responders

Responders in winter storm and freeze events face a variety of hazards themselves including slick or icy roads that could cause harm to responders if they are attempting to quickly respond to an emergency as is often the case. Crashed emergency vehicles and injuries to responders are always a possibility, but their chances increase during a winter storm event. Winter storms can also make it difficult to access more rural areas if roads are snowed over and vehicles cannot pass through.

Continuity of Operations

Generally, continuity of operations can be maintained during a winter storm event in Wake County. However, winter storms do have the potential to affect power transmission and can make it difficult for emergency management employees to arrive to work. As a result, there will likely be some disruption of operations during a winter storm event.

Built Environment (Property, Facilities, and Infrastructure)

Schools

Winter storms have the potential to impact public and private school schedules through closings and delays. Poor driving conditions, lack of power and heat, and mechanical problems with school buses and equipment due to cold weather conditions are potential concerns.

School closures and delays can lead to logistical problems for teachers and school administrators, especially in the event of end-of-term exams and standardized testing schedules. It can also result in logistical problems for making up school days; however, Wake County has “built in” a number of snow days in the academic calendar to account for possible cancellations due to winter weather.[16]

Critical Infrastructure and Key Resources

Winter storms have the potential to create hazardous driving conditions leading to accidents on roadways. The North Carolina Climate Office reports that 70 percent of winter-weather–related injuries are a result of accidents on the road.[17] The North Carolina Highway Patrol call volume can double during a winter storm compared to a typical 24-hour period. This creates significant problems for emergency workers. Accidents can cause highways to become as “large parking lots” as well as cause motorists to strand their vehicles, making it difficult for emergency workers to reach those who need assistance. In general, major and local roadways become severely impacted when temperatures drop, making pre-treatment solutions ineffective. Transportation impacts can be minimized during early- and late-season events when paved surfaces are able to warm sufficiently to prevent winter precipitation accumulation.

Winter storms can also result in delays and cancellations of flights at airports in Wake County due to slick conditions on runways. There is also the potential of a loss of power that can close the airport. The

[16] Fuhrmann, C. M., Connolly, R. P., & Konrad, C. E. (2009). *Winter storms: An overlooked source of death, destruction, and inconvenience in the Carolina Piedmont Region.* 66th Eastern Snow Conference, Niagara-on-the-Lake, Ontario, Canada. Retrieved May 7, 2012, from http://www.sercc.com/projects/WinterImpactsSERCC.pdf

[17] State Climate Office of North Carolina. *Winter weather—impacts*. Retrieved May 7, 2012, from http://www.nc-climate.ncsu.edu/climate/winter_wx/Impacts.php

most notable example of this was after the January 2000 snowstorm in which RDU airport lost power on two occasions and had to close for a week.

Utilities
One of the primary identified impacts of winter storms on Wake County is the disruption of utilities. In 2009, 50 percent of winter storms that impacted the RDU general area resulted in power outages to at least 10,000 customers in the Raleigh-Durham area.[18]

Additional utilities that are at risk of being affected include telephone, internet, cable, and water. Newspaper reports typically cite trees falling on electrical wires—as well as trees that have already been damaged from previous incidents that fall during a winter storm—or the stress caused by ice accumulation as main causes for power outages.

Economy
In the event of a winter storm, there is a high potential of business and office closures, modified business and office hours, and cancellation or postponement of sporting and other planned events in the county. This can be contributed to poor road conditions (including icy and slick conditions) that result in fewer people using the roads to get to their destination or a loss of power and heat that result in a loss of operations at specific facilities. Businesses that seek the most benefit from a winter storm event are those associated with cleanup, recovery operations, or rebuilding.

Environment
Winter storms have an impact on the environment through the clearing of roadways. Snow on the roads can pick up contaminants from chemicals and oil products in traffic as well as the salt mixture that is used to de-ice the roads. These contaminants can be carried to nearby waterways, which, contaminates water sources and is absorbed by groundwater.

In addition, vegetation can be damaged by these storm types. Vegetation destruction reduces available habitats, and threatens wildlife.

Geologic Hazards

5.11 EARTHQUAKE

5.11.1 Background

An earthquake is movement or trembling of the ground produced by sudden displacement of rock in the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of caverns. Earthquakes can affect hundreds of thousands of square miles, cause damage to property measured in the tens of billions of dollars, result in loss of life and injury to hundreds of thousands of persons, and disrupt the social and economic functioning of the affected area.

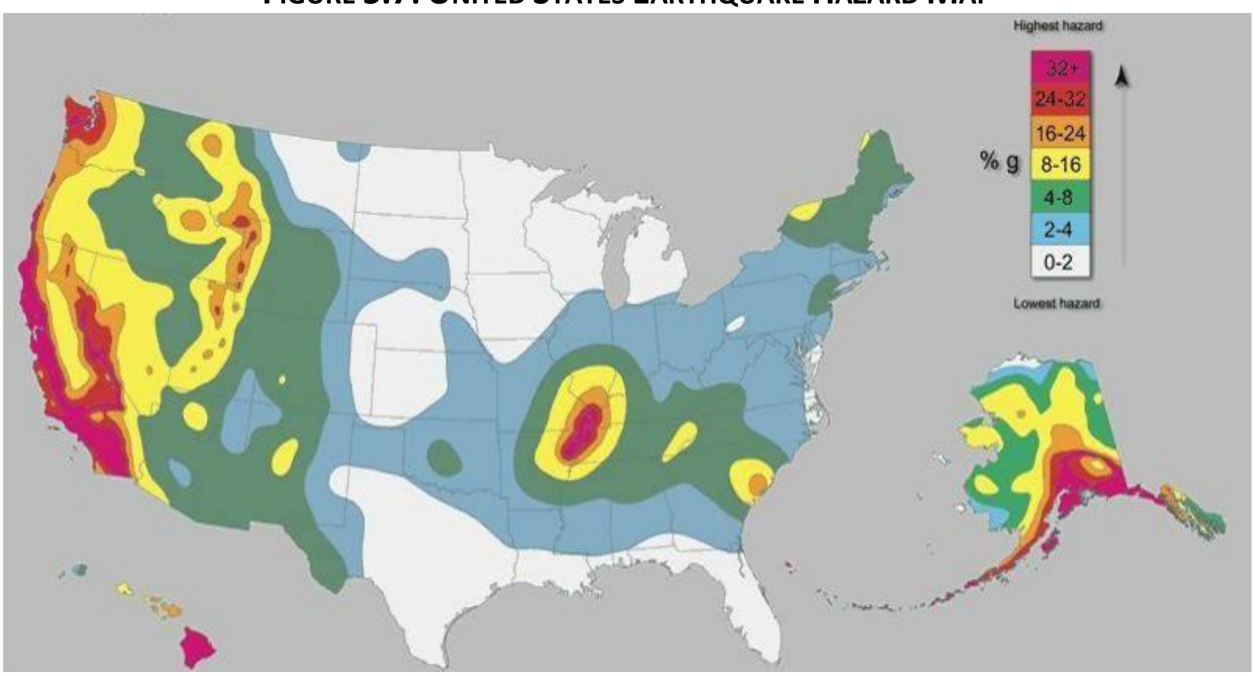
[18] Fuhrmann, C. M., Connolly, R. P., & Konrad, C. E. (2009). *Winter storms: An overlooked source of death, destruction, and inconvenience in the Carolina Piedmont Region.* 66th Eastern Snow Conference, Niagara-on-the-Lake, Ontario, Canada. Retrieved May 7, 2012, from http://www.sercc.com/projects/WinterImpactsSERCC.pdf

Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the amplitude and duration of the shaking, which are directly related to the earthquake size, distance from the fault, site, and regional geology. Other damaging earthquake effects include landslides, the down-slope movement of soil and rock (mountain regions and along hillsides), and liquefaction, in which ground soil loses the ability to resist shear and flows much like quick sand. In the case of liquefaction, anything relying on the substrata for support can shift, tilt, rupture, or collapse.

Most earthquakes are 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 10 tectonic plates. 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.

The greatest earthquake threat in the United States is along tectonic plate boundaries and seismic fault lines located in the central and western states; however, the Eastern United State does face moderate risk to less frequent, less intense earthquake events. **Figure 5.7** shows relative seismic risk for the United States.

FIGURE 5.7: UNITED STATES EARTHQUAKE HAZARD MAP



Source: United States Geological Survey

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 (**Table 5.35**). Each unit increase in magnitude on the Richter Scale corresponds to a 10-fold increase in wave amplitude, or a 32-fold increase in energy.

Intensity is most commonly measured using the Modified Mercalli Intensity (MMI) Scale based on direct and indirect measurements of seismic effects. The scale levels are typically described using roman numerals, ranging from "I" corresponding to imperceptible (instrumental) events to "XII" for catastrophic (total destruction). A detailed description of the Modified Mercalli Intensity Scale of earthquake intensity and its correspondence to the Richter Scale is given in **Table 5.36**.

TABLE 5.35: RICHTER SCALE

RICHTER MAGNITUDES	EARTHQUAKE EFFECTS
< 3.5	Generally not felt, but recorded.
3.5 - 5.4	Often felt, but rarely causes damage.
5.4 - 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1 - 6.9	Can be destructive in areas up to about 100 kilometers across where people live.
7.0 - 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or >	Great earthquake. Can cause serious damage in areas several hundred kilometers across.

Source: Federal Emergency Management Agency

TABLE 5.36: MODIFIED MERCALLI INTENSITY SCALE FOR EARTHQUAKES

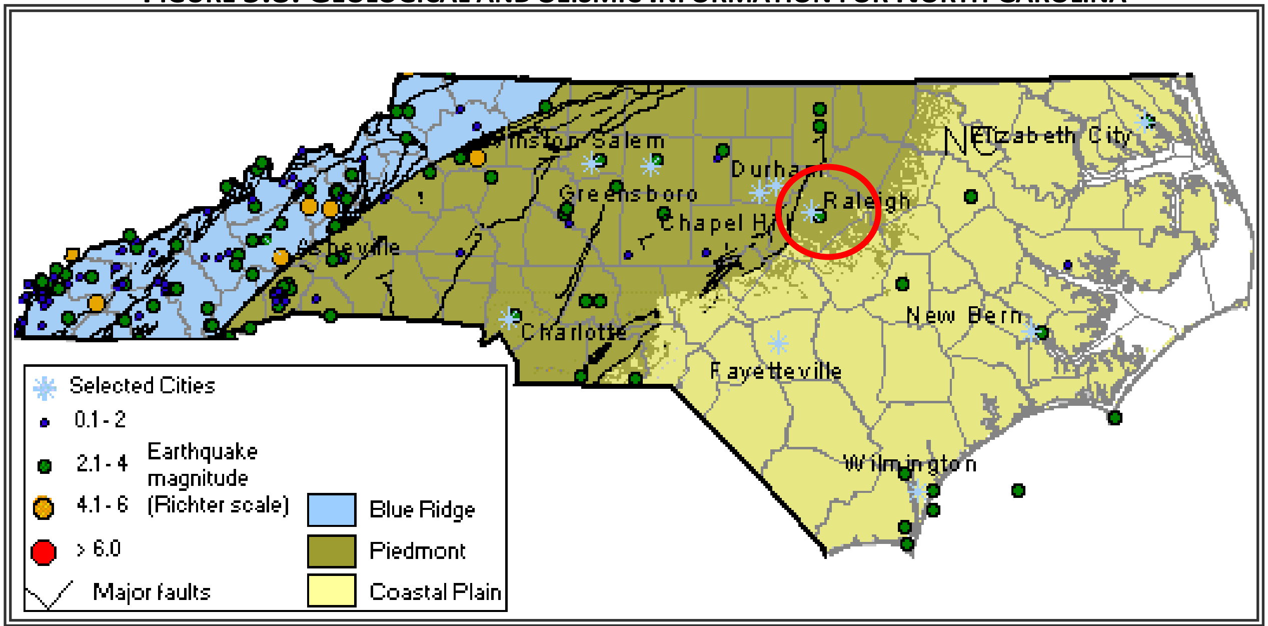
SCALE	INTENSITY	DESCRIPTION OF EFFECTS	CORRESPONDING RICHTER SCALE MAGNITUDE
I	INSTRUMENTAL	Detected only on seismographs.	
II	FEEBLE	Some people feel it.	< 4.2
III	SLIGHT	Felt by people resting; like a truck rumbling by.	
IV	MODERATE	Felt by people walking.	
V	SLIGHTLY STRONG	Sleepers awake; church bells ring.	< 4.8
VI	STRONG	Trees sway; suspended objects swing, objects fall off shelves.	< 5.4
VII	VERY STRONG	Mild alarm; walls crack; plaster falls.	< 6.1
VIII	DESTRUCTIVE	Moving cars uncontrollable; masonry fractures, poorly constructed buildings damaged.	
IX	RUINOUS	Some houses collapse; ground cracks; pipes break open.	< 6.9
X	DISASTROUS	Ground cracks profusely; many buildings destroyed; liquefaction and landslides widespread.	< 7.3
XI	VERY DISASTROUS	Most buildings and bridges collapse; roads, railways, pipes and cables destroyed; general triggering of other hazards.	< 8.1
XII	CATASTROPHIC	Total destruction; trees fall; ground rises and falls in waves.	> 8.1

Source: Federal Emergency Management Agency

5.11.2 Location and Spatial Extent

Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina. **Figure 5.8** is a map showing geological and seismic information for North Carolina.

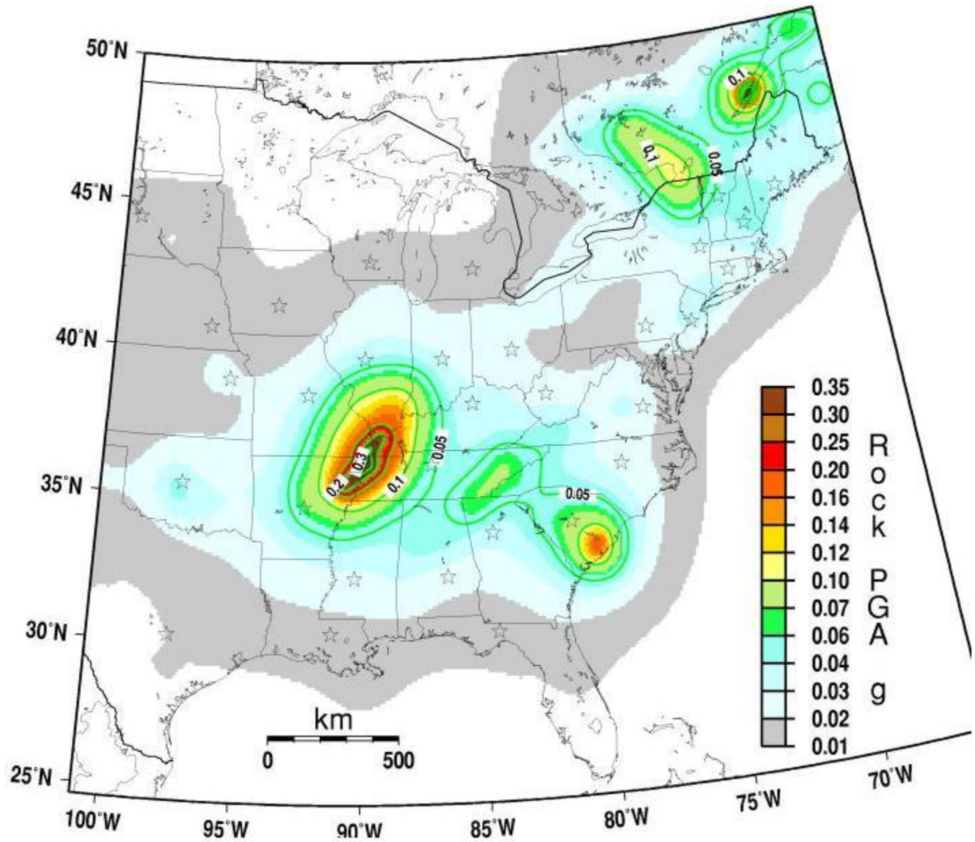
FIGURE 5.8: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure 5.9 shows the intensity level associated with Wake County, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Wake County lies within an approximate zone of level "2" to "3" ground acceleration. This indicates that the region as a whole exists within an area of low to moderate seismic risk.

FIGURE 5.9: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

5.11.3 Historical Occurrences

At least 13 earthquakes are known to have affected Wake County since 1811. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table 5.37** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table 5.38** presents a detailed occurrence of each event including the date, distance for the epicenter, Modified Mercalli Intensity, and magnitude (if known). [19]

TABLE 5.37: SUMMARY OF SEISMIC ACTIVITY IN WAKE COUNTY

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Apex	--	--	--
Cary	--	--	--
Fuquay-Varina	--	--	--
Garner	--	--	--
Holly Springs	--	--	--

[19] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

Knightdale	--	--	--
Morrisville	--	--	--
Raleigh	13	VIII	7.2
Rolesville	--	--	--
Wake Forest	--	--	--
Wendell	--	--	--
Zebulon	--	--	--
Unincorporated Area	--	--	--
WAKE COUNTY TOTAL	**13**	**VIII**	**7.2**

Source: National Geophysical Data Center

TABLE 5.38: SIGNIFICANT SEISMIC EVENTS IN WAKE COUNTY (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI
Wake County				
None reported				
Apex				
None reported				
Cary				
None reported				
Fuquay-Varina				
None reported				
Garner				
None reported				
Holly Springs				
None reported				
Knightdale				
None reported				
Morrisville				
None reported				
Raleigh				
Raleigh	12/16/1811	987.0	7.2	4
Raleigh	1/23/1812	987.0	7.1	2
Raleigh	3/10/1828			5
Raleigh	8/27/1833			3
Raleigh	4/29/1852			3
Raleigh	9/1/1886	343.0		8
Raleigh	9/1/1886	343.0		7
Raleigh	5/31/1897	249.0		3
Raleigh	11/25/1898			4
Raleigh	1/1/1913	302.0		3
Raleigh	3/5/1914	511.0		3
Raleigh	2/21/1916	350.0		2
Raleigh	11/20/1969	277.0	4.3	4

Location	Date	Epicentral Distance (km)	Magnitude	MMI
Rolesville				
None reported				
Wake Forest				
None reported				
Wendell				
None reported				
Zebulon				
None reported				

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Wake County, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table 5.39.**

TABLE 5.39: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 – 1*	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812*	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852*	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886*	Charleston, SC	7.3	X	VII
05/31/1897*	Giles County, VA	5.8	VIII	VI
01/01/1913*	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957	Buncombe County, NC	3.7	VI	VI
11/24/1957	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Wake County occurrences.

** Conflicting reports on this event, intensity in North Carolina could have been either V or VI

Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

5.11.4 Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Wake County is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. Therefore, the annual probability level for the county is estimated between 1 and 10 percent (possible).

5.11.5 Consequence Analysis

People (The Public and Public Confidence)

Earthquakes in Wake County generally are not high impact events that cause injury or death as most are moderate. The public typically experiences some shaking in these events and the greatest threat to health and well-being is often from objects falling from shelves. Public confidence would likely not be affected in the event of an earthquake.

Responders

There would be little impact on responders in the event of an earthquake, again, because Wake County is only likely to experience a moderate earthquake magnitude at a maximum. Since there would be very little damage to infrastructure, responders would likely not be impacted in their ability to respond to an earthquake.

Continuity of Operations

During and after an earthquake, continuity of operations could relatively easily be maintained and there would likely be little disruption to services or operations.

Built Environment (Property, Facilities, and Infrastructure)

Ground shaking is the primary cause of damage to the built environment during an earthquake. There are three important variables that determine the amount of damage: the intensity of the quake, local soil characteristics, and the quality of the impacted structures. The amount of damaged caused by an earthquake is strongly influenced by soil characteristics. The velocity at which the rock or soil transmits shear waves is the main contributor to ground shaking. Shaking is increased by soft, thick, or wet soil types.

Certain building types are particularly vulnerable to earthquake damage: wood-frame multi-unit buildings, single-family homes, mobile homes, and unreinforced masonry buildings.[20] The most susceptible structures are wood-frame, multi-story, mixed-use buildings that have large openings on the first floor for garages or commercial space and housing on the upper floors. During an earthquake, these types of structures could sway or even collapse. According to HAZUS-MH, there are approximately 183,668 buildings within the county that are built of wood, which is approximately 75 percent of the total building stock. The latest Wake County property data show 40 properties that are described as "stores with apartments and offices" with a total building value of almost $12 million, but these properties represent much less than 1 percent of county property.

[20] Association of Bay Area Governments. (2012). *Guide to housing vulnerable resources*. Retrieved March 11, 2012, from http://quake.abag.ca.gov/housing/

Single-family homes built prior to the 1970s are often not bolted to their foundations, and walls surrounding crawl spaces are not braced (i.e., cripple walls). Typical earthquake damage to these structures include cracked foundations, chimneys breaking at the roof line, wood frames coming off their foundations, and racking of cripple walls. The latest Wake County property data show there are 39,548 single-family housing units built before the 1970s with a total building value of $4.58 billion. These properties represent 12 percent of the county.

Mobile homes that are built of light-weight metal or a combination of steel frame and wood are easily damaged by a quake. Mobile homes installed prior to 1995 were often not attached to their foundations and could shift off their supports. Based on data from HAZUS-MH, the county contains 13,934 manufactured homes, which make up approximately 5.7 percent of the bounty's building stock.

The last type of susceptible building material is unreinforced masonry—masonry walls that have not been reinforced with steel. These buildings were often built before 1960 in an era when reinforcing was not generally used, anchorage to floors and roofs was missing, and use of low-strength lime mortar was common. Earthquake damage to these buildings can be severe. A lack of reinforcement and tie-downs can result in substantial damage in the form of cracked or leaning walls. Damage may also occur between the walls, and separation between the framing and walls could lead to full collapse due to a lack of vertical support. HAZUS-MH reports a total of 10,997 masonry buildings within the county (4.5 percent), but the number of unreinforced buildings is unknown.

Critical Infrastructure and Key Resources

Critical infrastructure and key resources within Wake County include assets, systems, and networks that are vital to the continued operation of government services. The incapacitation or destruction of these resources would have a debilitating effect on the county's security, economy, and/or public health. There are a handful of key resource categories that could be impacted by an earthquake including transportation systems, communication systems, and utility systems. Historically, the county has not been impacted by an earthquake with more than a moderate intensity so damage to these resources would be very minor; however, an inspection of certain features after a strongly felt earthquake may be necessary.

Economy

There are three sources of economic loss associated with an earthquake: property damage and business interruption costs; cost to repair public transportation, communication, or utility systems; and debris removal costs. Historically, there have been no economic losses from earthquakes felt within the county.

Environment

There would be no substantial impacts to the environment following a large earthquake that is felt in Wake County with a moderate intensity. Secondary effects from the damage of the key resources mentioned above (e.g., utility systems) could impact the environment, but the probability of this type of situation is very small. There is no doubt that a ruptured pipeline would release dangerous materials that could damage the surrounding environment.

5.12 LANDSLIDE

5.12.1 Background

A landslide is the downward and outward movement of slope-forming soil, rock, and vegetation, which is driven by gravity. Landslides may be triggered by both natural and human-caused changes in the environment, including heavy rain, rapid snow melt, steepening of slopes due to construction or erosion, earthquakes, volcanic eruptions, and changes in groundwater levels.

There are several types of landslides: rock falls, rock topple, slides, and flows. Rock falls are rapid movements of bedrock, which result in bouncing or rolling. A topple is a section or block of rock that rotates or tilts before falling to the slope below. Slides are movements of soil or rock along a distinct surface of rupture, which separates the slide material from the more stable underlying material. Mudflows, sometimes referred to as mudslides, mudflows, lahars or debris avalanches, are fast-moving rivers of rock, earth, and other debris saturated with water. They develop when water rapidly accumulates in the ground, such as heavy rainfall or rapid snowmelt, changing the soil into a flowing river of mud or "slurry." Slurry can flow rapidly down slopes or through channels and can strike with little or no warning at avalanche speeds. Slurry can travel several miles from its source, growing in size as it picks up trees, cars, and other materials along the way. As the flows reach flatter ground, the mudflow spreads over a broad area where it can accumulate in thick deposits.

Landslides are typically associated with periods of heavy rainfall or rapid snow melt and tend to worsen the effects of flooding that often accompanies these events. In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides. Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly.

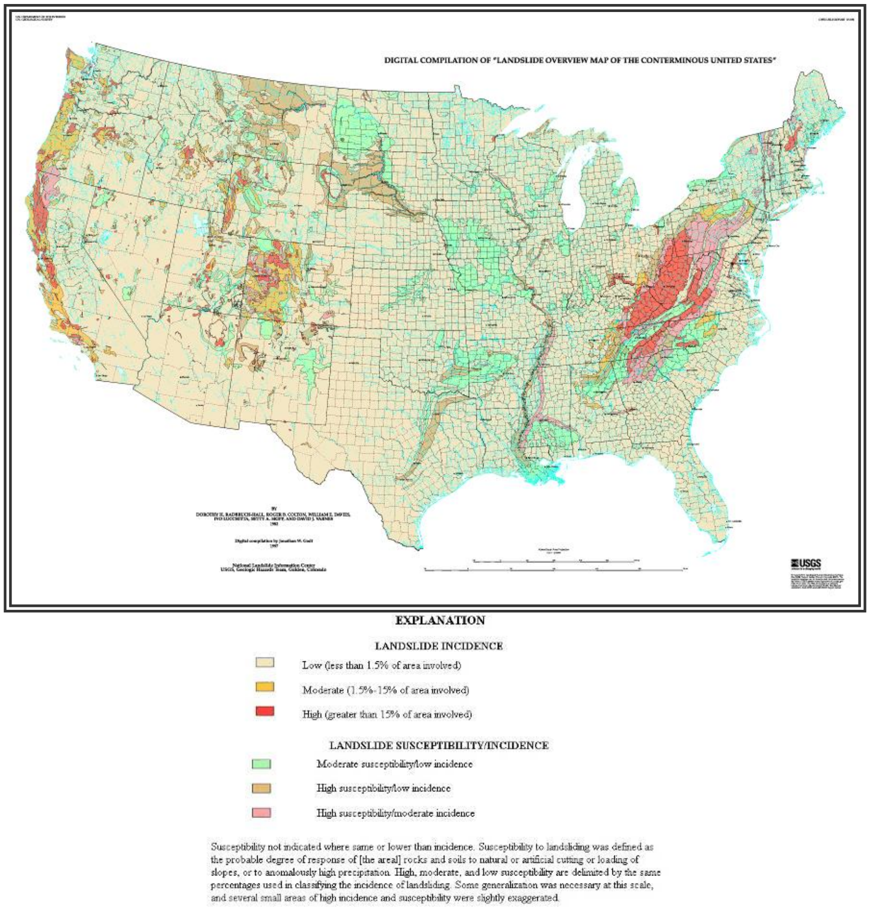
Among the most destructive types of debris flows are those that accompany volcanic eruptions. A spectacular example in the United States was a massive debris flow resulting from the 1980 eruptions of Mount St. Helens, Washington. Areas near the bases of many volcanoes in the Cascade Mountain Range of California, Oregon, and Washington are at risk from the same types of flows during future volcanic eruptions.

Areas that are generally prone to landslide hazards include previous landslide areas, the bases of steep slopes, the bases of drainage channels, and developed hillsides where leach-field septic systems are used. Areas that are typically considered safe from landslides include areas that have not moved in the past, relatively flat-lying areas away from sudden changes in slope, and areas at the top or along ridges set back from the tops of slopes.

According to the United States Geological Survey, each year landslides cause $5.1 billion (2009 dollars) in damage and between 25 and 50 deaths in the United States.[21] **Figure 5.10** delineates areas where large numbers of landslides have occurred and areas that are susceptible to landsliding in the conterminous United States.[22]

[21] United States Geological Survey (USGS). United States Department of the Interior. "Landslide Hazards – A National Threat." 2005.
[22] This map layer is provided in the U.S. Geological Survey Professional Paper 1183, Landslide Overview Map of the Conterminous United States, available online at: http://landslides.usgs.gov/html_files/landslides/nationalmap/national.html.

FIGURE 5.10: LANDSLIDE OVERVIEW MAP OF THE CONTERMINOUS UNITED STATES



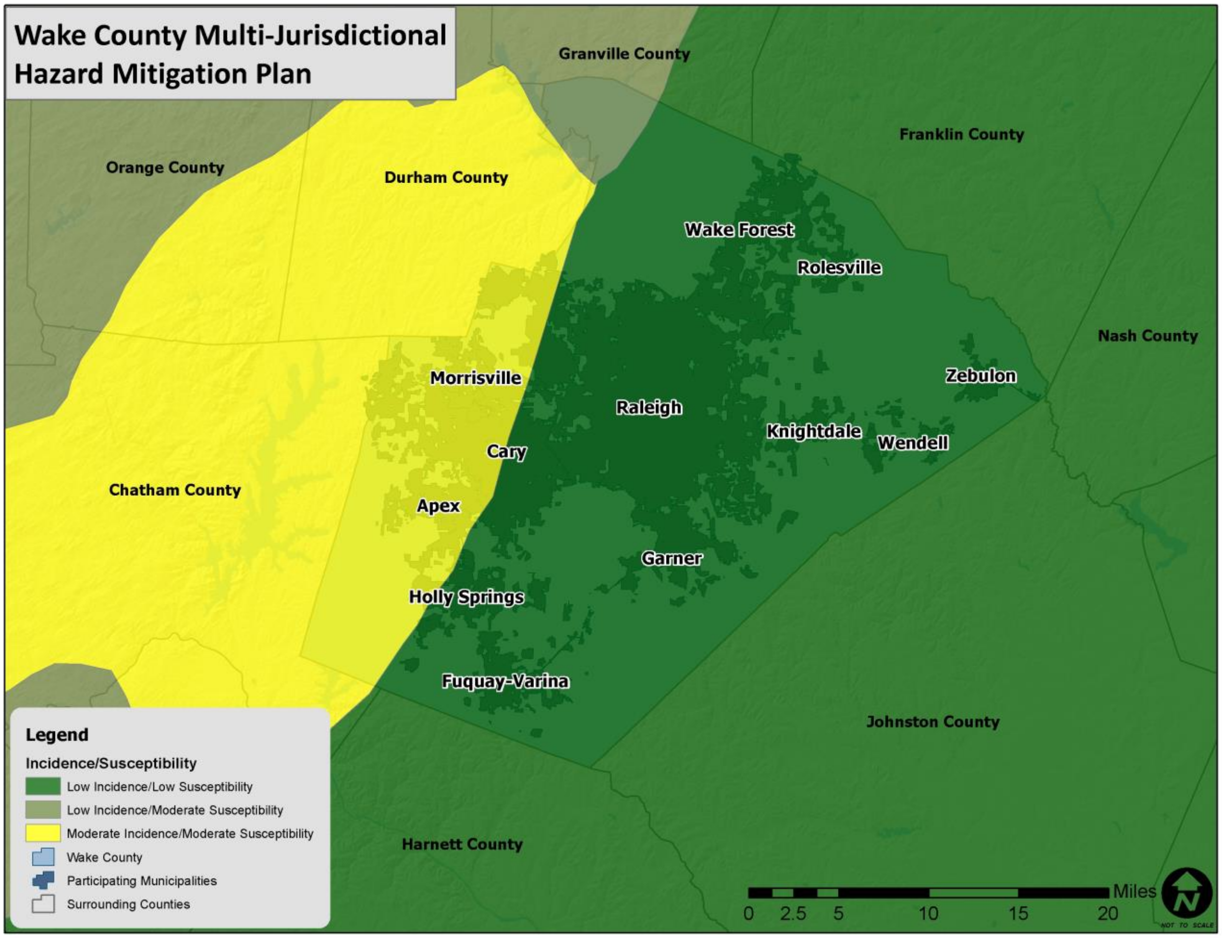
Source: USGS

5.12.2 Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Wake County, though the overall risk is relatively low.

According to **Figure 5.11** below, the majority of the county has relatively low landslide activity. However there is a small area along the western border of the county that has a moderate incidence and moderate susceptibility. In all other areas, there is low susceptibility.

FIGURE 5.11: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

5.12.3 Historical Occurrences

Steeper topography in some areas of Wake County makes the planning area moderately susceptible to landslides. Most landslides are caused by heavy rainfall combined with building on steeper slopes that was not previously possible. **Table 5.40** presents a summary of the landslide occurrence events as provided by the North Carolina Geological Survey[23]. The locations of the landslide events presented in the aforementioned tables are presented in **Figure 5.12**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred.

TABLE 5.40: SUMMARY OF LANDSLIDE ACTIVITY IN WAKE COUNTY

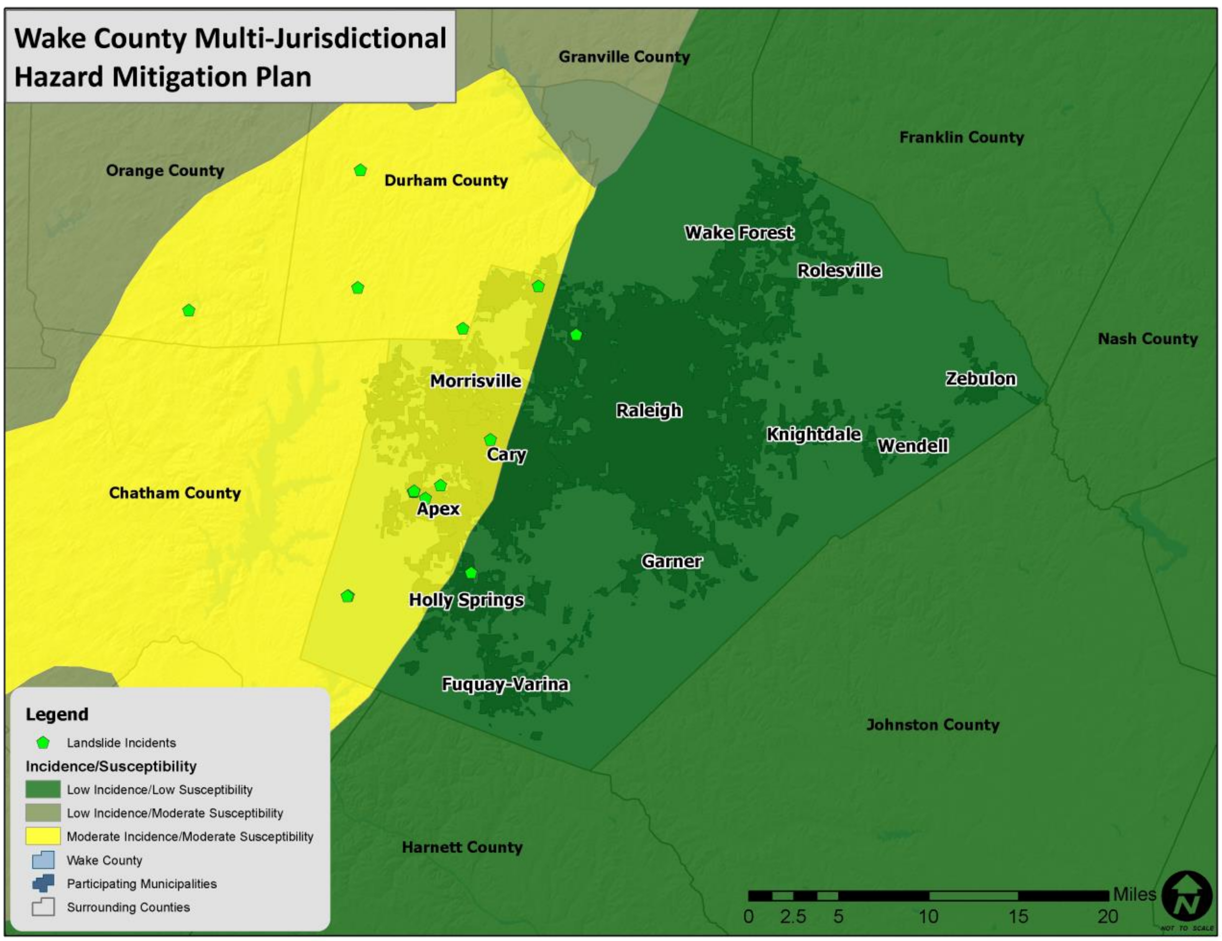
Location	Number of Occurrences
Apex	3
Cary	1

[23] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

Location	Number of Occurrences
Fuquay-Varina	0
Garner	0
Holly Springs	1
Knightdale	0
Morrisville	0
Raleigh	2
Rolesville	0
Wake Forest	0
Wendell	0
Zebulon	0
Unincorporated Area	4
WAKE COUNTY TOTAL	**11**

Source: North Carolina Geological Survey

FIGURE 5.12: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

5.12.4 Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Wake County have greater risk than others given factors such as steepness on slope and modification of slopes.

5.12.5 Consequence Analysis

People (The Public and Public Confidence)

Although there could be some impacts on people from a landslide in Wake County, these impacts would likely be relatively minor, resulting in few injuries. Since the susceptibility is relatively low for most of the county, the likelihood of a major landslide affecting the public is not high and public confidence would probably not be affected by a landslide.

Responders

Since landslides are a relatively low probability event and their extent is likely to be small, impacts on responders are unlikely. However, landslide events often cause the greatest harm when they block roadways, and this would have a negative impact on responders if they were limited in their transportation capacity.

Continuity of Operations

Continuity of operations would probably not be impacted by landslides as it is unlikely that enough personnel or resources would be affected to cause a breakdown of operations.

Built Environment (Property, Facilities, and Infrastructure)

Very little of the built environment is susceptible to the landslide hazard. For a detailed analysis of the impacts on the built environment from landslides, see *Section 6: Hazard Vulnerability.*

Economy

The greatest economic impact from a landslide would occur if roads had to be closed due to the event as this would disrupt the normal flow of business and potentially cost money. However, given the likely nature of landslides in Wake County, economic impacts would be relatively low.

Environment

Environmental impacts from a landslide will likely be minor in Wake County. Although a landslide has the potential to cause debris and dirt to block rivers and dirty waterways or change the terrain and impact farmland and forests, the magnitude of landslide that might affect Wake County is small enough that the impacts would be negligible.

Hydrologic Hazards

5.13 DAM AND LEVEE FAILURE

5.13.1 Background

Worldwide interest in dam and levee safety has risen significantly in recent years. Aging infrastructure, new hydrologic information, and population growth in floodplain areas downstream from dams and near levees have resulted in an increased emphasis on safety, operation, and maintenance.

There are approximately 80,000 dams in the United States today, the majority of which are privately owned. Other owners include state and local authorities, public utilities, and federal agencies. The benefits of dams are numerous: they provide water for drinking, navigation, and agricultural irrigation. Dams also provide hydroelectric power, create lakes for fishing and recreation, and save lives by preventing or reducing floods.

Though dams have many benefits, they also can pose a risk to communities if not designed, operated, and maintained properly. In the event of a dam failure, the energy of the water stored behind even a small dam is capable of causing loss of life and great property damage if development exists downstream. If a levee breaks, scores of properties may become submerged in floodwaters and residents may become trapped by rapidly rising water. The failure of dams and levees has the potential to place large numbers of people and great amounts of property in harm's way.

5.13.2 Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table 5.41** explains these classifications.

TABLE 5.41: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

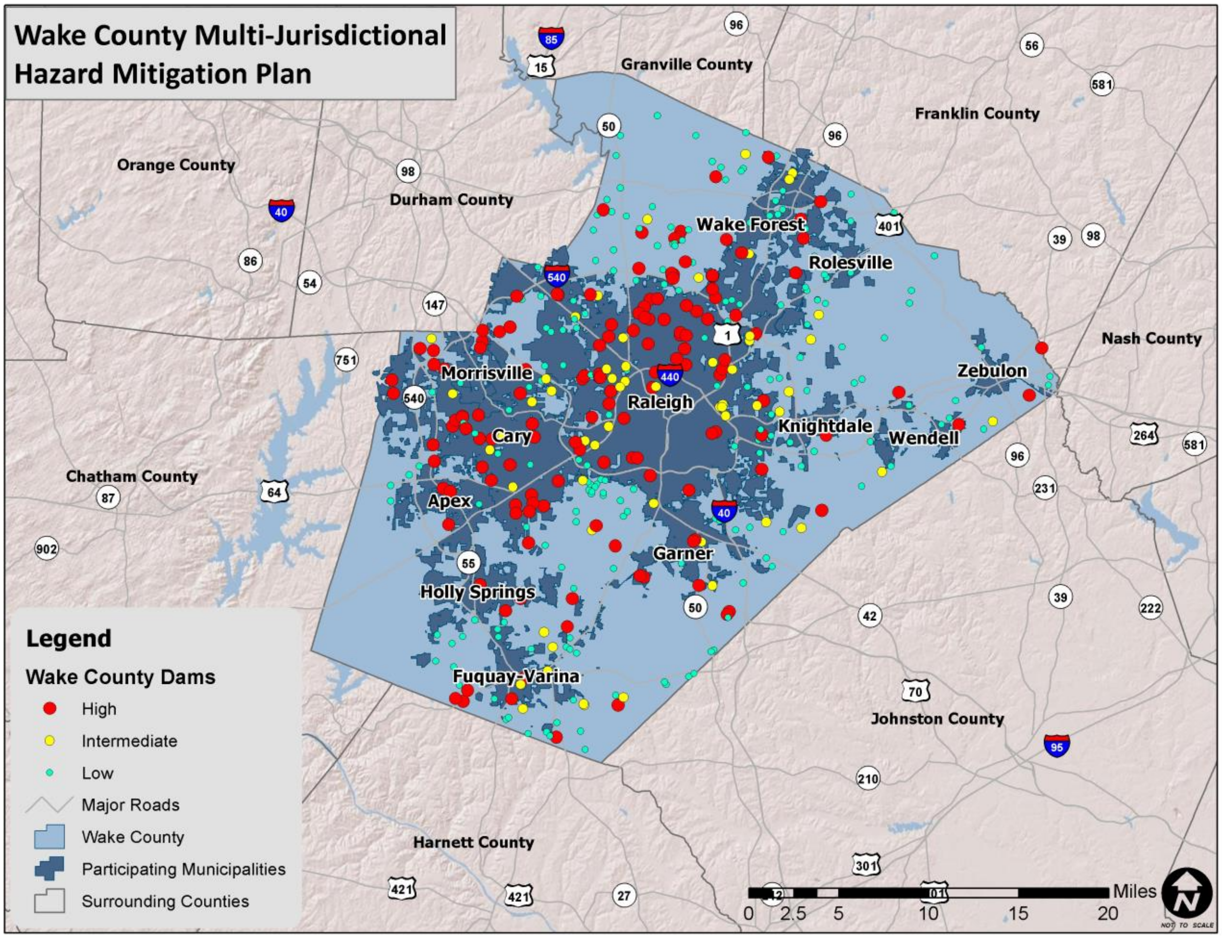
According to the North Carolina Division of Energy, Mineral, and Land Resources, there are 401 dams in Wake County.[24] **Figure 5.13** shows the dam location and the corresponding hazard ranking for each. Of these dams, 144 are classified as high hazard potential. These high hazard dams are summarized by county in **Table 5.42** and listed in **Table 5.43**.

TABLE 5.42: SUMMARY OF HIGH HAZARD DAM LOCATION

Location	Number High Hazard Dams
Apex	3
Cary	23
Fuquay-Varina	2
Garner	4
Holly Springs	2
Knightdale	1
Morrisville	4
Raleigh	57
Rolesville	0
Wake Forest	3
Wendell	1
Zebulon	0
Unincorporated Area	44
WAKE COUNTY TOTAL	**144**

[24] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE 5.13: WAKE COUNTY DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE 5.43: WAKE COUNTY HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Wake County				
Falls Of The Neuse Dam	High	0	1128100	Federal
Lake Benson Dam	High	463	7200	Local Gov
Crabtree Dam 20-A	High	0	2500	Local Gov
Crabtree Creek Dam 5-A	High	0	3010	Local Gov
Garner Ww Lagoon #1	High	25	394	Local Gov
Garner Ww Lagoon #2	High	25	306	Local Gov
Neuse River Waste Water Treatment Plant Equalization Basin	High	7.5	114	Local Gov
Bunn Lake Dam	High	120	975	Private
Johnson Pond Dam	High	9	95	Private
Crossgate Lake Dam #1	High	13.1	207	Private
Crossgate Dam #2	High	0	40	Private

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Holding Lake Dam	High	11	145	Private
Panther Lake Dam	High	82	253	Private
Sunset Lake Dam	High	98.1	750	Private
Robertson'S Pond	High	25	259	Private
Rdu Wastewater Dam	High	1.6	22.5	Private
Rtp South Dam	High	77	708	Private
Crooked Creek	High	0	40	Private
Pendleton Lake	High	0	10	Private
Johnson Pond Dam	High	0	5	Private
Coachman Trail Lake Dam Lower	High	2	93	Private
Stonebridge Lake Dam	High	0	45	Private
Herndon Pond Dam	High	0	22	Private
Springdale Estates Upper Dam	High	0	75	Private
Coachman Trail Lake Dam Upper	High	0	180	Private
Byrd Dam	High	1	10	Private
Fuller Lake Dam	High	0	70	Private
Bailey Dam	High	6	76	Private
Marshall Pond #2	High	4	59	Private
Howell Dam	High	3	36	Private
Manchester Dam	High	0	88	Private
Crossgate Dam #3	High	0	12	Private
Chateau Lapointe Dam H	High	0	90	Private
Cozart Pond Dam	High	2	0	Private
Underwood Pond Dam	High	4	27	Private
Betts Pond Dam	High	5	40	Private
Breckenridge Recreation Center Dam	High	3	38	Private
Hasentree Golf Communtiy Dam	High	0	139	Private
RTP W-5 Dam	High	47	700	Private
State Fair H & L Dam	High	6	78	State
Lake Wheeler Dam	High	560	10800	Utility
Burnside Drive Dam	High	3	12	
Seymour Farms Pond Dam	High	0.7	7	
Rosewood Subdivision Dam	High	1	6	
Apex				
Lake Pine Dam	High	0	163	Local Gov
Haddon Hall Dam	High	5	42	Private
Haddon Hall Upper Dam	High	1.1	0	Private
Cary				
Fred G Bond Dam	High	80	666	Local Gov
Tryon Road Dam	High	0	0	Local Gov
Jack Rigsbee Dam	High	2	20	Private
Preston Crossings Dam	High	2	18.8	Private
Rigsbee Dam	High	3	24	Private
Barbee Dam	High	1.9	12	Private
Blackhawk Dam	High	3.2	26	Private

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Adams Dam	High	2	17	Private
Coronado Lake Dam	High	4.4	26	Private
Hobby Dam	High	2	16	Private
Regency Park Dam	High	27.3	350	Private
Kildaire Farms Dam	High	30	420	Private
Lochmere Dam	High	70	728	Private
Audubon Parc Dam	High	0.9	8.1	Private
Lake Amberly Dam	High	14.1	0	Private
Searstone	High	1.3	9	Private
Panther Creek Dam	High	24	202	
Lochmere Lake Dam #2	High	16.3	196	
Loch Highlands Dam	High	6.4	59	
Lake Crabtree	High	473	8950	
Huggins Glen Dam	High	0	80	
Powell Tract Dam	High	0	9999	
Woolner Dam	High	1	11	
Fuquay-Varina				
Parker Lake Dam	High	0	75	Private
Jones Pond Dam	High	3	19	Private
Garner				
Massengill Dam	High	6	82	Private
Eagle Ridge Golf Course Dam	High	5.9	0	Private
Weston #1	High	0	10.8	
Weston #2	High	0	10	
Holly Springs				
Bass Lake Dam	High	58.6	910	Local Gov
Windcrest	High	4.2	42	Local Gov
Knightdale				
Myrick Lake Dam	High	0	5	Private
Morrisville				
Crabtree Creek W/S #1 (PL-566)	High	64	480	Local Gov
Crabtree Creek W/S Dam #18	High	16	661	Local Gov
Perimeter Park West Dam	High	1	10	Private
Breckenridge Tract 9 & 10 Dam	High	3	83	Private
Raleigh				
Shelley Lake	High	53	4269	Local Gov
Lake Lynn	High	55.7	2292	Local Gov
Eastgate Park Dam	High	3	27	Local Gov
Crabtree Creek W/S Structure #11a	High	44.5	3327	Local Gov
E.M. Johnson Water Plant B	High	13.1	383	Local Gov
E.M. Johnson Plant A Dam	High	6.4	110	Local Gov
Hedingham Dam #1	High	14.8	152	Private
Gresham Lake Dam	High	65	1755	Private
Shaw Lake Dam	High	4	55	Private

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Baker Lake Dam	High	5	60	Private
Turfgrass Lake Dam #3	High	11	85	Private
Lakes Apartment Dam	High	3	21.6	Private
Brentwood Today Lake Dam	High	0	12	Private
Em Johnson Alum Sludge Lagoon Dam	High	6	108.3	Private
Alyson Pond	High	0	40	Private
Lakemont Dam	High	8.3	91	Private
Cedar Hills Lake Dam	High	0	20	Private
Northshore Lake Dam	High	8	63	Private
Bullard And Patterson Dam	High	0.75	2.5	Private
Camp Pond Dam	High	4	24	Private
Wooten Pond Dam	High	0	40	Private
Ammons Lake Dam Upper	High	0	50	Private
Ammons Lake Dam Lower	High	8	352	Private
Longview Lake Dam Lower	High	12	143	Private
Longview Lake Upper Dam	High	5.5	44	Private
North Ridge Lake Dam Upper	High	15	168	Private
North Ridge Lake Dam Lower	High	0	161	Private
North Blvd Comm Center Dam	High	0	20	Private
Hart-George Pond	High	2	18	Private
Williams-Johnson Pond Dam	High	0	44	Private
The Lakes Lower Dam	High	5	41	Private
Summer Lake Dam	High	4.3	18	Private
Meredith College Dam	High	3	34	Private
Underwood Dam	High	3.1	30	Private
Ward Transformer Dike	High	0	13	Private
Martin Marietta #1 Dam	High	3.6	59	Private
Lakeside Dam	High	3	23	Private
Leadmine Lake Dam	High	10	92	Private
Delta Lake	High	3	42	Private
Olde Raleigh Dam #3	High	2.8	24	Private
Olde Raleigh Dam #1	High	1.6	19.7	Private
Olde Raleigh Dam #2	High	3.2	25.1	Private
Landmark Apts. Dam	High	2	18	Private
Remington Park Dam	High	6	84	Private
Newton Commons Dam	High	0.75	8.6	Private
Lake Plaza Dam	High	2	18.4	Private
Lake Raleigh Dam	High	66	781	State
Lake Johnson Dam	High	147.5	3090	Utility
Carolina Country Club Water Harvesting Pond Dam	High	0	0	
Raintree Lake	High	0	0	
NCSU Centennial Campus Farm Pond Dam	High	2	20	
Heathrow Dam	High	0	26	
Mallard Pond Dam	High	0	8	

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Art Museum Dam	High	0	10	
Brier Creek Village Center Dam	High	0	0	
Carolina Pines Dam	High	4.3	53	
Bedford at Falls River Dam #1	High	0	4	
Rolesville				
None reported				
Wake Forest				
Wake Forest Water Supply Dam	High	50	945	Local Gov
Lewis Dam	High	10	80	Private
St. Andrews Plantation Dam	High	3	23	Private
Wendell				
Timberlake Dam	High	0	9999	
Zebulon				
None reported				

Source: North Carolina Division of Land Resources, 2012

5.13.3 Historical Occurrences

A total of 36 statewide dams failed as a result of Hurricane Floyd (1999)—14 high-hazard, 5 intermediate, and 12 low-hazard dams were damaged or destroyed.[25] Federal grant funding helped the North Carolina Dam Safety Program develop an Emergency Action Plan that was implemented following the 1999 hurricane season. Dam safety personnel instituted the following measures:

- Inspection of high-hazard dams at least every 2 years and of intermediate and low-hazard dams at least every 5 years
- Notification of dam owners regarding deficiencies found in dams and needed maintenance or engineering and repairs and enforcement of recommendations if needed
- Review of plans for construction of new dams
- Review of plans for dam repairs, modifications, or decommissioning
- Inspection during construction activities as resources permit
- Inspection prior to impoundment once construction is completed
- Inspection during and after extreme events such as floods
- Maintenance of databases and records of dams under North Carolina jurisdiction

Several dam failures have occurred in Wake County, but none have been significant**. Table 5.44** displays the classification of each dam at time of failure and the main cause of the damage. **Figure 5.14** shows the location of dam failure occurrences within the county

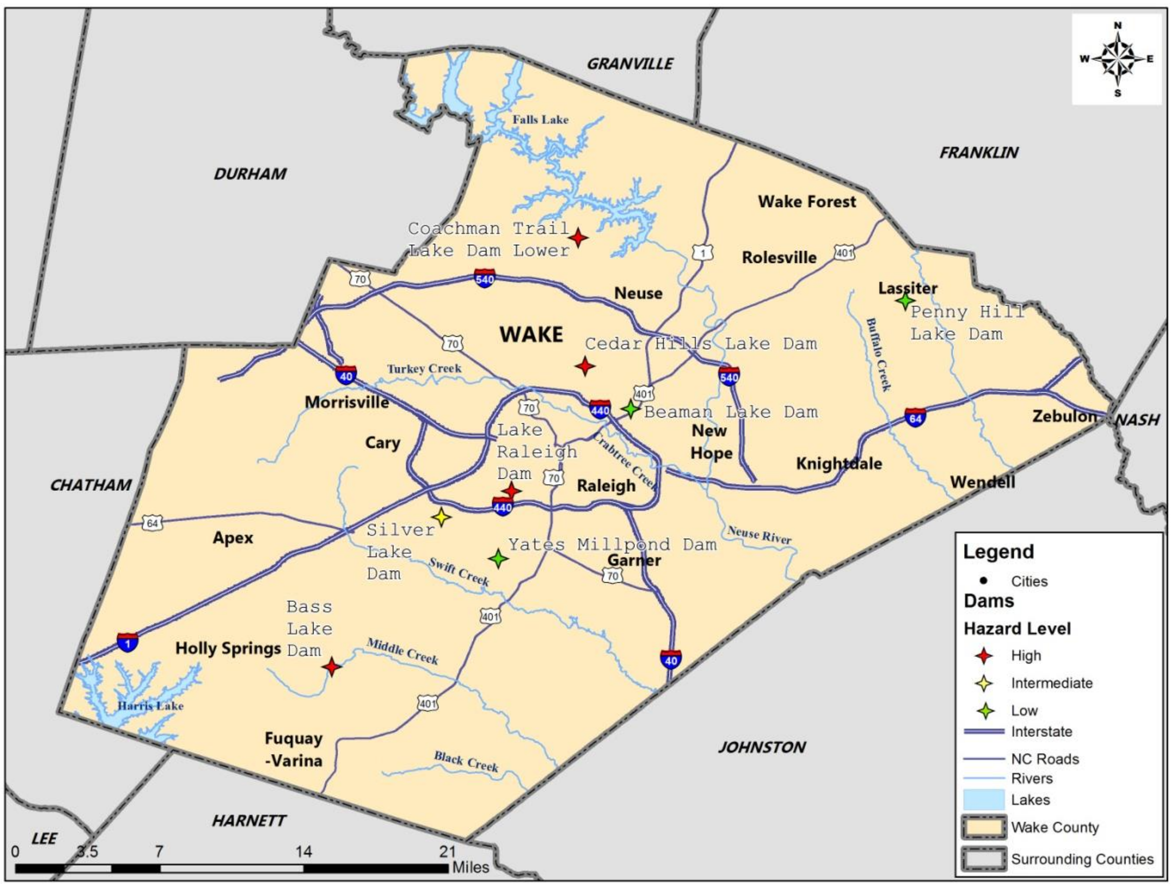
[25] Town of Apex Hazard Mitigation Plan. (2010). *Appendix A: Hazard Identification and Analysis*.

TABLE 5.44: HISTORICAL DAM FAILURES IN WAKE COUNTY

Name	Location	Class at Time of Failure	Current Class	Cause of Failure
Cedar Hills*	Wake County	Intermediate	High	Heavy rain (mid 1970s)
Coachman's Trail Lower	Wake County	High	High	Heavy rain (late 1970s)
Beaman's Lake***	Wake County	Intermediate	Intermediate	Heavy rain (late 1980s)
Bass Lake*	Holly Springs	Low	High	Hurricane Fran (1996)
Lake Raleigh	Raleigh	High	High	Hurricane Fran (1996)
Penny Hill Lake	Zebulon	Low	Low	Hurricane Fran (1996)
Silver Lake**	Raleigh	Intermediate	High	Hurricane Fran (1996)
Yates Mill Pond	Wake County	Intermediate	Intermediate	Hurricane Fran (1996)

*High due to downstream development
**High due to increased traffic on downstream road
***Exempt due to dam height

FIGURE 5.14: WAKE COUNTY DAM FAILURE LOCATIONS WITH HAZARD RANKING



Source: Wake County HIRA Report, 2012

5.13.4 Probability of Future Occurrence

Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events and they can occur. No further analysis will be completed in Section 6: *Vulnerability Assessment* as more sophisticated dam breach plans (typically completed by the U.S. Army Corp of Engineers) have been completed for dams of concern in the region.

5.13.5 Consequence Analysis

People (The Public and Public Confidence)

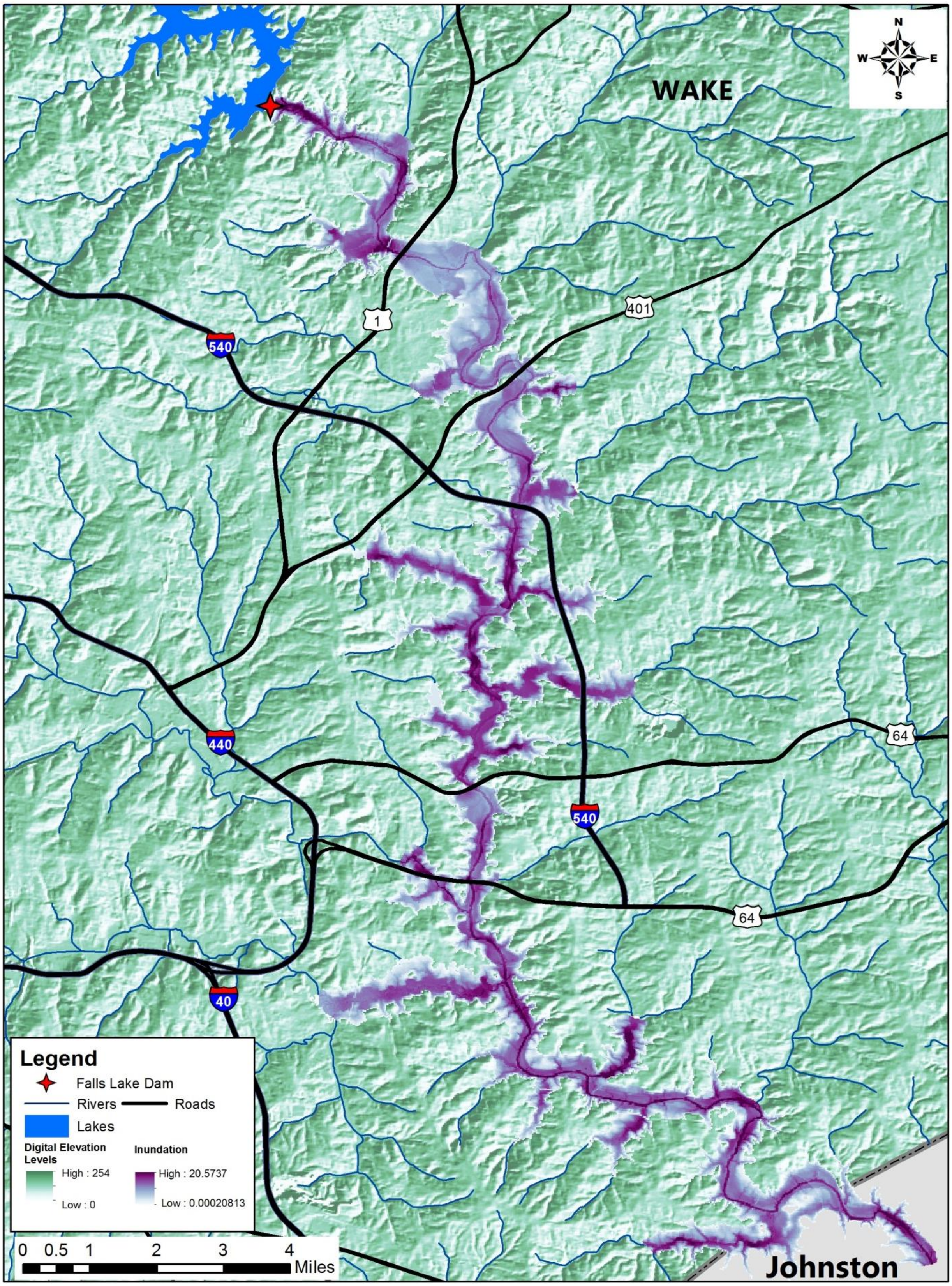
In the case of a dam failure, a person's vulnerability is largely determined by their proximity to a dam and/or a river. The number and characteristics of people that would be impacted by a catastrophic failure of Falls Lake Dam are shown in **Table 5.45**. **Figure 5.15** shows the inundation area for a dam failure at Falls Lake. A dam failure could have a significant effect on public confidence due to the large-scale, perceived impact of the event.

Table 5.45: Age, Sex, Race, and Income of Impacted Population

Name of Variable	Falls Lake Dam Failure	Wake County
Total Number of People	20,366	900,993
Population Under Age 18	6,072	234,613
Population Ages 18–64	13,178	589,831
Population Age 65 and Older	1,116	76,549
Number of Males (all ages)	9,671	438,792
Number of Females (all ages)	10,696	462,201
Median Age (both sexes)	31	35
White Only	9,801	560,536
Black or African American Only	7,431	182,793
American Indian or Alaskan Native Only	122	4,503
Asian Only	909	48,287
Native Hawaiian or Pacific Islander Only	8	387
Other Race	1,457	21,455
Number of People with Hispanic Origins	2,991	87,922
Per Capita Income (5-year estimate)*	$33,435	$35,122

**Only available at the Census tract level*

FIGURE 5.15: FALLS LAKE DAM FAILURE INUNDATION AREA



Emergency Sheltering
HAZUS-MH is able to estimate the number of households that are expected to be displaced from their homes due to the dam failure and may require accommodations in temporary emergency shelters. The model estimates 500 households will be displaced and a total of 1,195 people could seek shelter.

Responders
Response in a dam failure would be similar in many ways to the response in a flood and, as such, responders would be impacted in similar ways, although probably to a lesser degree than in a flood situation as the impact would probably be somewhat more geographically confined. For more information, please see the flood analysis section.

Continuity of Operations
Continuity of operations in a dam failure event would likely be maintained without much difficulty. Although it could be impacted to some degree due to power loss or road closures that would prevent staff from continuing operations, generally there would be minimal disruption to operations.

Built Environment (Property, Facilities, and Infrastructure)
According to the most recent Wake County property data, a total of 7,471 occupied housing units could potentially be impacted but not necessarily displaced by a failure of the Falls Lake Dam, which is approximately 3 percent of the total occupied units in the county. Almost 2 percent of land acreage would be impacted by the same event. A summary of building and property characteristics within the inundation area are shown in **Table 5.46**.

TABLE 5.46: CHARACTERISTICS OF BUILDINGS AND PROPERTIES IMPACTED

Name of Variable	Dam Failure	Wake County
Property Impacted (Acres)	9,846	501,265
Percent of Wake County Property Impacted	1.96%	--
Total Housing Units	7,877	386,187
Number of Occupied Units	7,471	235,493
Number of Vacant Units	407	121,300
Estimated Building Value Losses	$960,990,794	--

The land classification codes of property impacted by the dam failure inundation are listed in **Table 5.47**and show that the inundation area is mostly comprised of exempt, vacant, residential, agricultural-farm, floricultural-farm, and historic-site properties. Residential property (less than or equal to 10 acres) represents the largest estimated building value loss—approximately $818 billion—that could be severely damage. Exempt land represents the second largest estimated building value loss of approximately $57 million. Apartment and commercial properties both represent a loss of approximately $27 million.

TABLE 5.47: LAND CLASSIFICATION OF ESTIMATED BUILDING VALUE LOSSES

Code	Land Classification	Acres Impacted	Estimated Building Value Losses	Estimated Land Value Losses
A	AC-W/IMP	46.37	$139,203.10	$1,300,322.55
B	AC >10 Acres-Home Site	325.88	$3,783,189.87	$8,777,768.35
C	Commercial	270.51	$26,952,290.20	$11,383,768.38

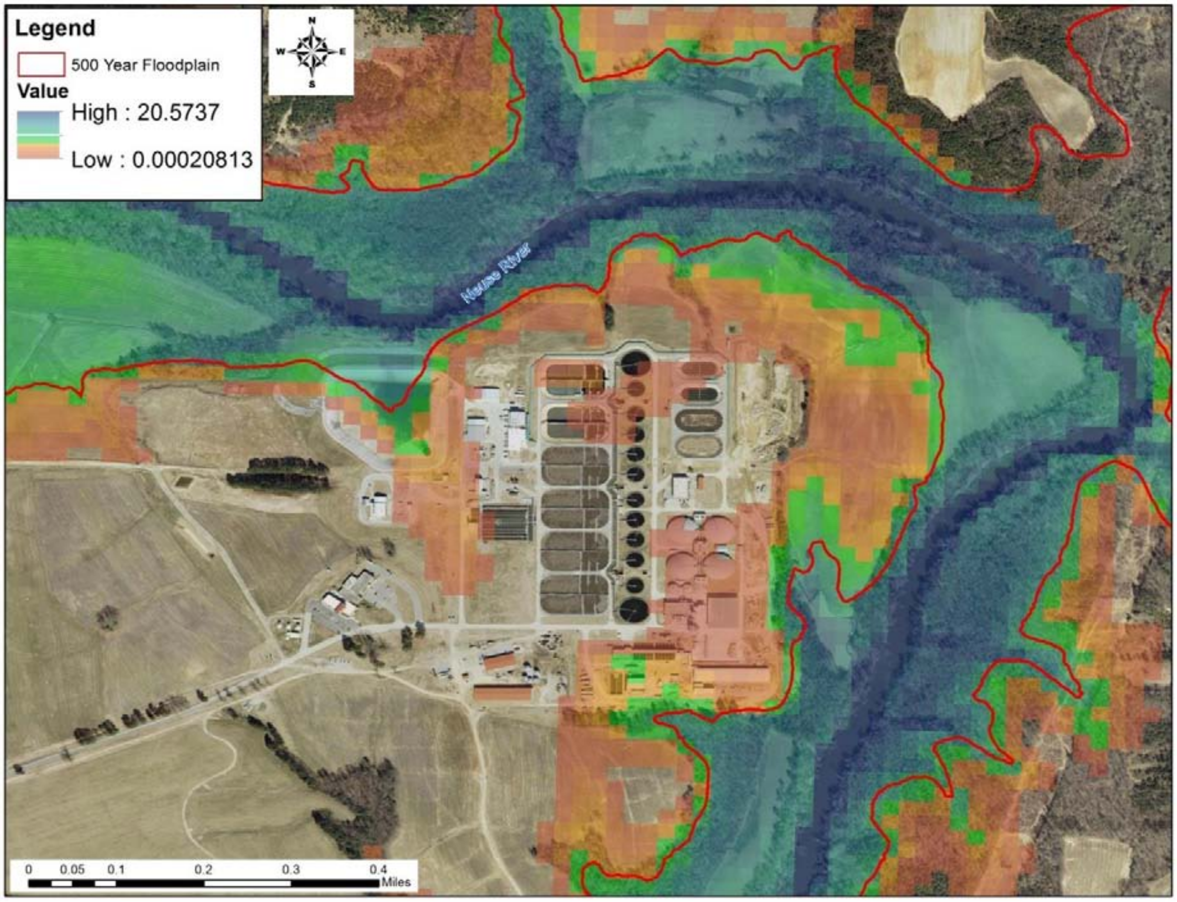
Code	Land Classification	Acres Impacted	Estimated Building Value Losses	Estimated Land Value Losses
D	Industrial	246.81	$13,853,035.63	$8,592,182.85
E	Exempt	2826.22	$57,398,122.30	$123,629,671.86
F	Agricultural-Farm	870.92	$1,050,918.62	$22,593,710.01
G	Apartment	44.87	$26,961,440.89	$3,280,356.55
H	Historic Site	711.12	$382,053.00	$2,439,171.90
I	Homeowners Association	52.81	$1,787.59	$1,733,571.11
O	MA+Condo	2.18	$0.00	$0.00
P	Private Exempt	8.26	$0.00	$0.00
R	Residence -< 10 Acres-Home Site	17.56	$2,495,482.72	$1,285,219.94
S	State-Assessed	1555.04	$817,889,458.69	$236,771,395.06
T	Mobile Home Park	14.21	$0.00	$324,959.98
U	Golf Course	148.67	$6,706,114.88	$7,052,571.22
V	Vacant	246.48	$2,807,422.44	$3,540,036.41
W	Water/Sewer System	1574.25	$1,692.68	$54,577,472.08
Y	Floriculture-Farm	29.31	$49,237.76	$41,630.61
Z	Horticulture-Farm	832.15	$437,079.04	$26,993,004.32

Critical Infrastructure and Key Resources

Critical infrastructure and key resources within Wake County include assets, systems, and networks that are vital to the continued operation of government services. The incapacitation or destruction of these resources would have a debilitating effect on the county's security, economy, and/or public health. One fixed site key resource—the Neuse River Wastewater Treatment Plant—could be damaged by a catastrophic failure of Falls Lake Dam. **Figure 5.16**shows the potential extent of inundation at the plant. Consequences of flooding the treatment plant include cessation of plant services and downstream water quality impacts. Submersion of the plant would cause a continuous discharge of untreated wastewater into the Neuse River. Wastewater usually contains organic matter, pathogens (disease-causing organisms), high concentrations of nutrients such as phosphorus and nitrogen, heavy metals, and some toxic chemicals. All of these could affect the health of people and ecosystems that live downstream from the plant. Life-threatening pathogens carried by sewage include dysentery, schistosomiasis, hepatitis A, and intestinal nematode infections.[26] Downstream wetlands may be impacted by algal blooms from wastewater discharges, which directly influences the penetration of sunlight and reduces the productivity of wetland flora. Destruction of wetland flora and fauna is also a possibility due to various toxic chemicals carried by untreated wastewater from local industrial facilities.

[26] Prüss-Üstün, A., Bos, R., Gore, F., & Bartram, J. (2008). *Safe water, better health*. Geneva: World Health Organization. Retrieved March 10, 2012, from http://www.who.int/quantifying_ehimpacts/publications/saferwater/en/index.html

FIGURE 5.16: INUNDATION OF THE NEUSE RIVER WASTEWATER TREATMENT PLANT



Economy

There would be three main sources of economic loss associated with a dam failure: property damage and business interruption costs, cost of emergency response services, and debris management costs.

Property Damage and Business Interruption

The total economic loss estimated for the dam failure is $78.25 million, which represents 10.69 percent of the total replacement value of the scenario buildings. Building losses are broken into two categories: direct building losses and business interruption losses. Direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. Business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood. The total building-related losses were $77.45 million. One percent of the estimated losses were related to the business interruption of the region. The residential occupancies made almost 59 percent of the total loss.

Debris Management

HAZUS-MH estimates the amount of debris that will be generated by the dam failure. The model separates debris into three general categories:

- Finishes—dry wall, insulation, etc.
- Structural—wood, brick, vinyl, etc.

- Foundation—concrete slab, concrete block, rebar

This distinction is made because of the different types of equipment required to handle the debris. The model estimates that a total of 1,220 tons of debris will be generated by the dam failure. If the debris tonnage is converted into an estimated number of truckloads, this incident would require 49 truckloads (25 tons per truck) to remove the debris.

Environment

The two main environmental concerns from a catastrophic dam failure include total destruction of wetland areas in close proximity to the dam and long-term damage to downstream wetlands. Impacts on wetland areas due to flooding are discussed in the flood hazard profile, and damage from inundation of the Neuse River wastewater treatment plant is covered in the key resources discussion above.

5.14 EROSION

5.14.1 Background

Erosion is the gradual breakdown and movement of land due to both physical and chemical processes of water, wind, and general meteorological conditions. Natural, or geologic, erosion has occurred since the Earth's formation and continues at a very slow and uniform rate each year.

There are two types of soil erosion: wind erosion and water erosion. Wind erosion can cause significant soil loss. Winds blowing across sparsely vegetated or disturbed land can pick up soil particles and carry them through the air, thus displacing them. Water erosion can occur over land or in streams and channels. Water erosion that takes place over land may result from raindrops, shallow sheets of water flowing off the land, or shallow surface flow, which becomes concentrated in low spots. Stream channel erosion may occur as the volume and velocity of water flow increases enough to cause movement of the streambed and bank soils. Major storms, such hurricanes in coastal areas, may cause significant erosion by combining high winds with heavy surf and storm surge to significantly impact the shoreline.

An area's potential for erosion is determined by four factors: soil characteristics, vegetative cover, topography climate or rainfall, and topography. Soils composed of a large percentage of silt and fine sand are most susceptible to erosion. As the clay and organic content of these soils increases, the potential for erosion decreases. Well-drained and well-graded gravels and gravel-sand mixtures are the least likely to erode. Coarse gravel soils are highly permeable and have a good capacity for absorption, which can prevent or delay the amount of surface runoff. Vegetative cover can be very helpful in controlling erosion by shielding the soil surface from falling rain, absorbing water from the soil, and slowing the velocity of runoff. Runoff is also affected by the topography of the area including size, shape, and slope. The greater the slope length and gradient, the more potential an area has for erosion. Climate can affect the amount of runoff, especially the frequency, intensity, and duration of rainfall and storms. When rainstorms are frequent, intense, or of long duration, erosion risks are high. Seasonal changes in temperature and rainfall amounts define the period of highest erosion risk of the year.

During the past 20 years, the importance of erosion control has gained the increased attention of the public. Implementation of erosion control measures consistent with sound agricultural and construction operations is needed to minimize the adverse effects associated with harmful chemicals run-off due to wind or water events. The increase in government regulatory programs and public concern has resulted in a wide range of erosion control products, techniques, and analytical methodologies in the United States. The preferred method of erosion control in recent years has been the restoration of vegetation.

5.14.2 Location and Spatial Extent

Erosion in Wake County is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Wake County soil has greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Wake County, particularly along the banks of rivers and streams, but it is not an extreme threat to any of the participating jurisdictions. No areas of concern were reported by the planning team.

5.14.3 Historical Occurrences

Several sources were vetted to identify areas of erosion in Wake County. This includes searching local newspapers, interviewing local officials, and reviewing previous hazard mitigation plans. Little information could be found beyond the hazard mitigation plans. Although erosion was mentioned in each of the plans and many of the jurisdictions have Erosion and Sedimentation Control Ordinances in effect, erosion was not addressed in any of the previous hazard mitigation plans.

5.14.4 Probability of Future Occurrences

Erosion remains a natural, dynamic, and continuous process for Wake County, and it will continue to occur. The annual probability level assigned for major erosion events is possible (between 1 and 10 percent annually). However, given the lack of historical events, location, data, and threat to life or property, no further analysis will be done in Section 6: *Vulnerability Assessment*.

5.14.5 Consequence Analysis

People (The Public and Public Confidence)

Typically, people are not directly impacted by erosion. However, sudden incidents prompting emergency action, such as a strong storm causing bluff failure, could result in injury or loss of life. People located nearby to waterways and streams in Wake County are most susceptible to erosion. However, since few major erosion areas were noted in the risk assessment, it is unlikely the erosion will have a major impact on the public here as it does in many coastal communities. As such, the impact on public confidence will be very limited.

Responders

Impacts to responder would be very low as erosion in Wake County does not occur at a fast enough rate to truly impact many response operations.

Continuity of Operations

Erosion will have little effect on continuity of operations in Wake County, again, because it is happening at to slow of a rate.

Built Environment (Property, Facilities, and Infrastructure)

Erosion can have an impact on the built environment, especially roads and pipelines and any infrastructure that requires relatively stable ground to exist upon. Erosion near roads will require consistent repairs that attempt to stabilize the ground. In Wake County, erosion tends to be a far lesser problem than in many coastal communities, however, there are areas in the county where erosion could potentially cause some issues, especially around rivers/streams.

Economy

Erosion impacts the economy when rebuilding of structures must take place in order to stabilize them. This can be especially detrimental if businesses are affected or have to shut down temporarily to deal with erosion issues. Erosion can also impact the economy through productivity losses if the loss of topsoil renders soil less fertile for farming and agriculture.

Environment

Generally, the environment is not impacted by erosion as it is a natural process that occurs over time, so the environment can adapt. However, rapid erosion that takes place as a result of human activity can impact environmental features by changing habitats and ecosystems in which plant and animal life exist.

5.15 FLOOD

5.15.1 Background

Flooding is the most frequent and costly natural hazard in the United States and is a hazard that has caused more than 10,000 deaths since 1900. Nearly 90 percent of presidential disaster declarations result from natural events where flooding was a major component.

Floods generally result from excessive precipitation and can be classified under two categories: general floods, precipitation over a given river basin for a long period of time along with storm-induced wave action, and flash floods, the product of heavy localized precipitation in a short time period over a given location. The severity of a flooding event is typically determined by a combination of several major factors, including stream and river basin topography and physiography, precipitation and weather patterns, recent soil moisture conditions, and the degree of vegetative clearing and impervious surface.

General floods are usually long-term events that may last for several days. The primary types of general flooding include riverine, coastal, and urban flooding. Riverine flooding is a function of excessive precipitation levels and water runoff volumes within the watershed of a stream or river. Coastal flooding is typically a result of storm surge, wind-driven waves, and heavy rainfall produced by hurricanes, tropical storms, and other large coastal storms. Urban flooding occurs where manmade development has obstructed the natural flow of water and decreased the ability of natural groundcover to absorb and retain surface water runoff.

Most flash flooding is caused by slow-moving thunderstorms in a local area or by heavy rains associated with hurricanes and tropical storms. However, flash flooding events may also occur from a dam or levee failure within minutes or hours of heavy amounts of rainfall or from a sudden release of water held by a retention basin or other stormwater control facility. Although flash flooding occurs most often along mountain streams, it is also common in urbanized areas where much of the ground is covered by impervious surfaces.

The periodic flooding of lands adjacent to rivers, streams, and shorelines (land known as a floodplain) is a natural and inevitable occurrence that can be expected to take place based upon established recurrence intervals. The recurrence interval of a flood is defined as the average time interval, in years, expected between a flood event of a particular magnitude and an equal or larger flood. Flood magnitude increases with increasing recurrence interval.

Floodplains are designated by the frequency of the flood that is large enough to cover them. For example, the 10-year floodplain will be covered by the 10-year flood and the 100-year floodplain by the 100-year flood. Flood frequencies, such as the 100-year flood, are determined by plotting a graph of the size of all known floods for an area and determining how often floods of a particular size occur. Another way of expressing the flood frequency is the chance of occurrence in a given year, which is the percentage of the probability of flooding each year. For example, the 100-year flood has a 1 percent chance of occurring in any given year and the 500-year flood has a 0.2 percent chance of occurring in any given year.

5.15.2 Location and Spatial Extent

There are areas in Wake County that are susceptible to flood events. Special flood hazard areas in the Wake County were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[27] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 835 square miles that make up Wake County, there are 76.8 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain) and 5.5 square miles of land in zone X500 (0.2-percent annual chance floodplain/500-year floodplain). The jurisdictional totals are presented below in **Table 5.48**.

TABLE 5.48: SUMMARY OF FLOODPLAIN AREAS IN WAKE COUNTY

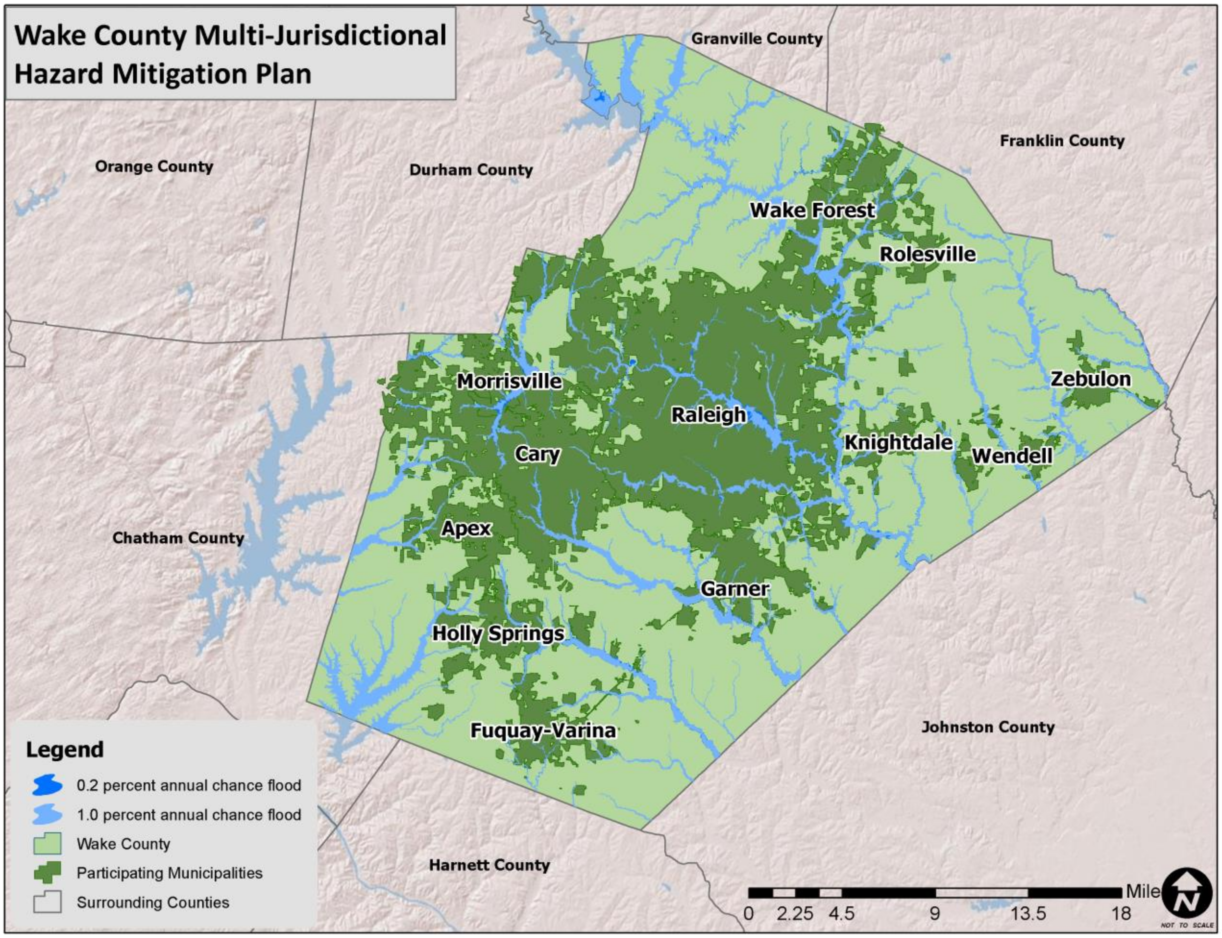
Location	100-year area (square miles)
Apex	0.68
Cary	4.49
Fuquay-Varina	0.54
Garner	1.10
Holly Springs	0.98
Knightdale	0.31
Morrisville	0.60
Raleigh	11.35
Rolesville	0.07
Wake Forest	1.56
Wendell	0.28
Zebulon	0.13
Unincorporated Area	54.68
WAKE COUNTY TOTAL	**76.77**

These flood zone values account for 9.2 percent of the total land area in Wake County. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses

[27] The county-level DFIRM data used for Wake County was updated in 2013 for each of the jurisdictions.

often do occur outside of delineated special flood hazard areas. **Figure 5.17** illustrates the location and extent of currently mapped special flood hazard areas for Wake County based on best available FEMA DFIRM data.

FIGURE 5.17: SPECIAL FLOOD HAZARD AREAS IN WAKE COUNTY



Source: Federal Emergency Management Agency

Additional, more detailed jurisdiction-level maps can be found in the annexes.

5.15.3 Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported a total of 100 events throughout Wake County since 1993.[28] A summary of these events is presented in **Table 5.49**. These events accounted for over $10.6 million (2013 dollars) in property damage throughout the region.[29] Specific information on flood events for each county, including date, type of flooding, and deaths and injuries, can be found in **Table 5.50**.

[28] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.
[29] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

TABLE 5.49: SUMMARY OF FLOOD OCCURRENCES IN WAKE COUNTY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Apex	2	0/0	$0
Cary	4	0/0	$0
Fuquay-Varina	3	0/0	$0
Garner	1	0/0	$0
Holly Springs	1	0/0	$0
Knightdale	0	0/0	$0
Morrisville	7	0/0	$0
Raleigh	36	0/0	$10,416,787
Rolesville	0	0/0	$0
Wake Forest	3	0/0	$0
Wendell	0	0/0	$0
Zebulon	0	0/0	$0
Unincorporated Area	43	0/0	$220,101
WAKE COUNTY TOTAL	**100**	**0/0**	**$10,636,888**

Source: National Climatic Data Center

TABLE 5.50: HISTORICAL FLOOD EVENTS IN WAKE COUNTY

	Date	Type	Deaths/ Injuries	Property Damage*
Wake County				
SRN	10/5/1995	FLASH FLOOD	0/0	$0
Northern	6/24/1995	FLASH FLOOD	0/0	$85,344
COUNTYWIDE	7/24/1997	FLASH FLOOD	0/0	$0
COUNTYWIDE	9/27/1999	FLASH FLOOD	0/0	$0
COUNTYWIDE	9/15/1999	FLASH FLOOD	0/0	$0
COUNTYWIDE	9/5/1999	FLASH FLOOD	0/0	$0
COUNTYWIDE	9/28/1999	FLASH FLOOD	0/0	$0
COUNTYWIDE	6/16/2001	FLASH FLOOD	0/0	$0
SOUTH PORTION	7/9/2001	FLASH FLOOD	0/0	$0
SOUTH PORTION	7/4/2001	FLASH FLOOD	0/0	$0
EAST PORTION	8/1/2003	FLASH FLOOD	0/0	$0
CENTRAL PORTION	8/8/2003	FLASH FLOOD	0/0	$0
CENTRAL PORTION	8/8/2003	FLASH FLOOD	0/0	$0
COUNTYWIDE	8/12/2004	FLASH FLOOD	0/0	$0
COUNTYWIDE	6/14/2006	FLASH FLOOD	0/0	$0
BRENTWOOD	4/27/2008	FLASH FLOOD	0/0	$0
MILLBROOK	4/27/2008	FLASH FLOOD	0/0	$0
MILLBROOK	9/6/2008	FLASH FLOOD	0/0	$119,405
ECHO HGTS	8/30/2008	FLASH FLOOD	0/0	$0
CARIO	8/28/2008	FLASH FLOOD	0/0	$0
ASBURY	5/5/2009	FLOOD	0/0	$0
MILLBROOK	5/5/2009	FLASH FLOOD	0/0	$0
BRENTWOOD	5/5/2009	FLASH FLOOD	0/0	$0

	Date	Type	Deaths/ Injuries	Property Damage*
COLLEGE VIEW	12/2/2009	FLASH FLOOD	0/0	$0
CAMP POLK	12/2/2009	FLASH FLOOD	0/0	$0
WESTOVER	12/2/2009	FLASH FLOOD	0/0	$0
CARALEIGH	1/25/2010	FLASH FLOOD	0/0	$0
WESTOVER	6/16/2009	FLASH FLOOD	0/0	$0
WILLOW	9/22/2009	FLASH FLOOD	0/0	$0
CARALEIGH	8/24/2010	FLASH FLOOD	0/0	$0
LEESVILLE	8/5/2010	FLASH FLOOD	0/0	$0
ASBURY	6/1/2010	FLASH FLOOD	0/0	$0
WILLIAMS XRDS	9/30/2010	FLASH FLOOD	0/0	$0
STARMOUNT	8/6/2011	FLASH FLOOD	0/0	$0
COLLEGE VIEW	9/21/2011	FLASH FLOOD	0/0	$5,464
MILLBROOK	7/30/2012	FLASH FLOOD	0/0	$0
MILLBROOK	9/6/2012	FLASH FLOOD	0/0	$0
MILLBROOK	9/18/2012	FLASH FLOOD	0/0	$0
MILLBROOK	9/8/2012	FLASH FLOOD	0/0	$9,888
COLLEGE VIEW	9/8/2012	FLASH FLOOD	0/0	$0
Apex				
APEX	7/27/2010	FLASH FLOOD	0/0	$0
APEX	7/27/2010	FLASH FLOOD	0/0	$0
Cary				
CARY	6/23/2006	FLASH FLOOD	0/0	$0
CARY	7/17/2007	FLASH FLOOD	0/0	$0
CARY	8/6/2011	FLASH FLOOD	0/0	$0
CARY	7/24/2011	FLASH FLOOD	0/0	$0
Fuquay-Varina				
FUQUAY SPGS	8/4/2000	FLASH FLOOD	0/0	$0
FUQUAY SPGS	7/17/2003	FLASH FLOOD	0/0	$0
FUQUAY SPGS	6/4/2004	FLASH FLOOD	0/0	$0
Garner				
Garner	6/11/2006	FLASH FLOOD	0/0	$0
Holly Springs				
Holly Springs	8/11/2001	FLASH FLOOD	0/0	$0
Knightdale				
None Reported				
Morrisville				
MORRISVILLE	7/29/2004	FLASH FLOOD	0/0	$0
MORRISVILLE	6/23/2006	FLASH FLOOD	0/0	$0
MORRISVILLE	6/23/2006	FLASH FLOOD	0/0	$0
MORRISVILLE	6/23/2006	FLASH FLOOD	0/0	$0
MORRISVILLE	8/30/2006	FLASH FLOOD	0/0	$0
MORRISVILLE	8/30/2008	FLASH FLOOD	0/0	$0
MORRISVILLE	5/5/2009	FLASH FLOOD	0/0	$0
Raleigh				
NE Raleigh	8/27/1995	FLASH FLOODING	0/0	$10,241298

	Date	Type	Deaths/ Injuries	Property Damage*
Raleigh	10/4/1995	FLASH FLOOD	0/0	$0
RALEIGH	9/6/1996	FLASH FLOOD	0/0	$0
RALEIGH	9/10/1996	FLASH FLOOD	0/0	$0
RALEIGH, WENDELL	9/10/1996	FLASH FLOOD	0/0	$0
RALEIGH	9/11/1996	FLASH FLOOD	0/0	$0
RALEIGH	10/8/1996	FLASH FLOOD	0/0	$0
RALEIGH	4/28/1997	FLASH FLOOD	0/0	$0
RALEIGH	1/16/1998	FLASH FLOOD	0/0	$79,768
RALEIGH	1/23/1998	URBAN/SML STREAM FLD	0/0	$0
RALEIGH	3/9/1998	FLASH FLOOD	0/0	$0
RALEIGH	3/19/1998	FLASH FLOOD	0/0	$0
RALEIGH	8/8/1998	URBAN/SML STREAM FLD	0/0	$31,907
RALEIGH	8/16/1998	URBAN/SML STREAM FLD	0/0	$63,814
RALEIGH	7/29/2000	FLASH FLOOD	0/0	$0
RALEIGH	8/1/2000	FLASH FLOOD	0/0	$0
RALEIGH	8/4/2000	FLASH FLOOD	0/0	$0
RALEIGH	9/3/2000	FLASH FLOOD	0/0	$0
RALEIGH	9/4/2000	FLASH FLOOD	0/0	$0
RALEIGH	9/25/2000	FLASH FLOOD	0/0	$0
RALEIGH	3/31/2002	FLASH FLOOD	0/0	$0
RALEIGH	6/28/2002	FLASH FLOOD	0/0	$0
RALEIGH	8/26/2002	FLASH FLOOD	0/0	$0
RALEIGH	10/11/2002	FLASH FLOOD	0/0	$0
RALEIGH	6/7/2003	FLASH FLOOD	0/0	$0
RALEIGH	7/29/2003	FLASH FLOOD	0/0	$0
RALEIGH	8/13/2004	FLASH FLOOD	0/0	$0
RALEIGH	8/30/2004	FLASH FLOOD	0/0	$0
RALEIGH	6/7/2005	FLASH FLOOD	0/0	$0
RALEIGH	6/7/2005	FLASH FLOOD	0/0	$0
RALEIGH	6/23/2006	FLASH FLOOD	0/0	$0
RALEIGH	6/16/2009	FLASH FLOOD	0/0	$0
RALEIGH	1/25/2010	FLASH FLOOD	0/0	$0
RALEIGH	9/30/2010	FLASH FLOOD	0/0	$0
RALEIGH	9/30/2010	FLASH FLOOD	0/0	$0
RALEIGH	8/6/2011	FLASH FLOOD	0/0	$0
Rolesville				
None Reported				
Wake Forest				
WAKE FOREST	8/26/1999	FLASH FLOOD	0/0	$0
WAKE FOREST	9/10/2001	FLASH FLOOD	0/0	$0
WAKE FOREST	12/2/2009	FLASH FLOOD	0/0	$0
Wendell				
None Reported				
Zebulon				
None Reported				

	Date	Type	Deaths/ Injuries	Property Damage*

Source: National Climatic Data Center

5.15.4 Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there have been 910 flood losses reported in Wake County through the National Flood Insurance Program (NFIP) since 1978, totaling over $21 million in claims payments. A summary of these figures for each jurisdiction is provided in **Table 5.51**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that many additional instances of flood loss in Wake County were either uninsured, denied claims payment, or not reported.

TABLE 5.51: SUMMARY OF INSURED FLOOD LOSSES IN WAKE COUNTY

Location	Flood Losses	Claims Payments
Apex	0	$0
Cary	83	$1,297,771
Fuquay-Varina	1	$5,783
Garner	18	$107,854
Holly Springs	3	$32,312
Knightdale	2	$17,361
Morrisville	3	$66,219
Raleigh	725	$18,503,795
Rolesville	0	$0
Wake Forest	0	$0
Wendell	6	$77,232
Zebulon	7	$183,092
Unincorporated Area	62	$787,324
WAKE COUNTY TOTAL	**910**	**$21,078,743**

Source: FEMA, NFIP

5.15.5 Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

Currently (as of July 2013), there are 131 non-mitigated repetitive loss properties located in Wake County, which accounted for 374 losses and more than $12.5 million in claims payments under the NFIP. The average claim amount for these properties is $33,471. Seventy-five of the one hundred and thirty-one properties are single family residential and the remaining are either multi-family residential, commercial, or government owned. Without mitigation these properties will likely continue to experience flood looses. **Table 5.52** presents summary information on repetitive loss properties and NFIP claims and policies for Wake County.

TABLE 5.52: REPETITIVE LOSS PROPERTIES IN WAKE COUNTY

Location	Number of Properties	Number of Losses	Total Payments
Apex	0	0	$0
Cary	13	33	$635,412
Fuquay-Varina	0	0	$0
Garner	4	8	$65,416
Holly Springs	0	0	$0
Knightdale	0	0	$0
Morrisville	0	0	$0
Raleigh	109	316	$11,500,659
Rolesville	0	0	$0
Wake Forest	0	0	$0
Wendell	0	0	$0
Zebulon	0	0	$0
Unincorporated Area	5	17	$316,761
WAKE COUNTY TOTAL	**131**	**374**	**$12,518,248**

REPETITIVE LOSS PROPERTIES IN WAKE COUNTY

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Apex	0	-	0	$0	$0	$0	$0
Cary	13	13 single family	33	$460,622	$174,791	$635,412	$19,255
Fuquay-Varina	0	-	0	$0	$0	$0	$0
Garner	4	4 single family	8	$64,119	$1,297	$65,416	$8,177
Holly Springs	0	-	0	$0	$0	$0	$0
Knightdale	0	-	0	$0	$0	$0	$0
Morrisville	0	-	0	$0	$0	$0	$0
Raleigh	109	54 single family, 23 multi-family residential, 32 non-residential,	316	$8,969,656	$2,531,003	$11,500,659	$36,394
Rolesville	0	-	0	$0	$0	$0	$0
Wake Forest	0	-	0	$0	$0	$0	$0
Wendell	0	-	0	$0	$0	$0	$0
Zebulon	0	-	0	$0	$0	$0	$0
Unincorporated Area	5	4 single family, 1 multi-family residential	17	$260,683	$56,078	$316,761	$18,633
WAKE COUNTY TOTAL	**131**		**374**	**$9,755,080**	**$2,763,169**	**$12,518,248**	**$33,471**

Source: National Flood Insurance Program

5.15.6 Probability of Future Occurrences

Flood events will remain a threat in Wake County, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability). The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above**,** which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

5.15.7 Consequence Analysis

People (The Public and Public Confidence)

The number and characteristics of people that would be impacted by a 100-year and a 500-year flood event are shown in **Table 5.53**. Public confidence is often impacted by flood events, especially when impacted people do not have flood insurance and are not covered by their home insurance policy. This can create public relations issues for the government.

Table 5.53: Age, Sex, Race, and Income of the Impacted Population

Name of Variable	100-year Flood	500-year Flood	Wake County
Total Number of People	38,428	43,446	900,993
Population Under Age 18	10,440	11,772	234,613
Population Ages 18–64	24,978	28,255	589,831
Population Age 65 and Older	3,009	3,419	76,549
Number of Males (all ages)	18,576	21,001	438,792
Number of Females (all ages)	19,851	22,444	462,201
Median Age (both sexes)	25	31	35
White Only	24,502	27,558	560,536
Black or African American Only	8,940	10,226	182,793
American Indian or Alaskan Native Only	219	242	4,503
Asian Only	1,756	2,047	48,287
Native Hawaiian or Pacific Islander Only	14	16	387
Other Race	1,986	2,200	21,455
Number of People with Hispanic Origins	4,309	4,813	87,922
Per Capita Income (5-year estimate)*	$33,167	$33,167	$35,122

**Only available at the Census tract level*

Responders

Responders are often affected by flooding because floods can trap people in their homes or in other locations, forcing responders to put their lives at risk to return members of the public to safety. Often responders in flood situations face blocked roads and have difficulty safely protecting citizens.

Continuity of Operations

Flooding can impact continuity of operations by knocking out power sources and preventing emergency management personnel from being able to do their jobs properly. Floods typically have some impact on continuity of operations as they can cause severe disruption to normal operations and have done so in the past in Wake County.

Built Environment (Property, Facilities, and Infrastructure)

Many buildings and structures could be impacted by a flood event. For a detailed analysis of flood prone properties, see *Section 6: Hazard Vulnerability.*

The land classification codes of property impacted by the floodplains are listed in **Table 5.54** and show that the floodplains are mostly comprised of exempt, vacant, State-assessed, agricultural-farm, and residential properties. Exempt land represents the largest estimated value—just more than $1 billion—that could be destroyed by a 500-year flood. Residential land is the second greatest estimated loss around $379 million and agricultural farm land losses is estimated at $98 million.

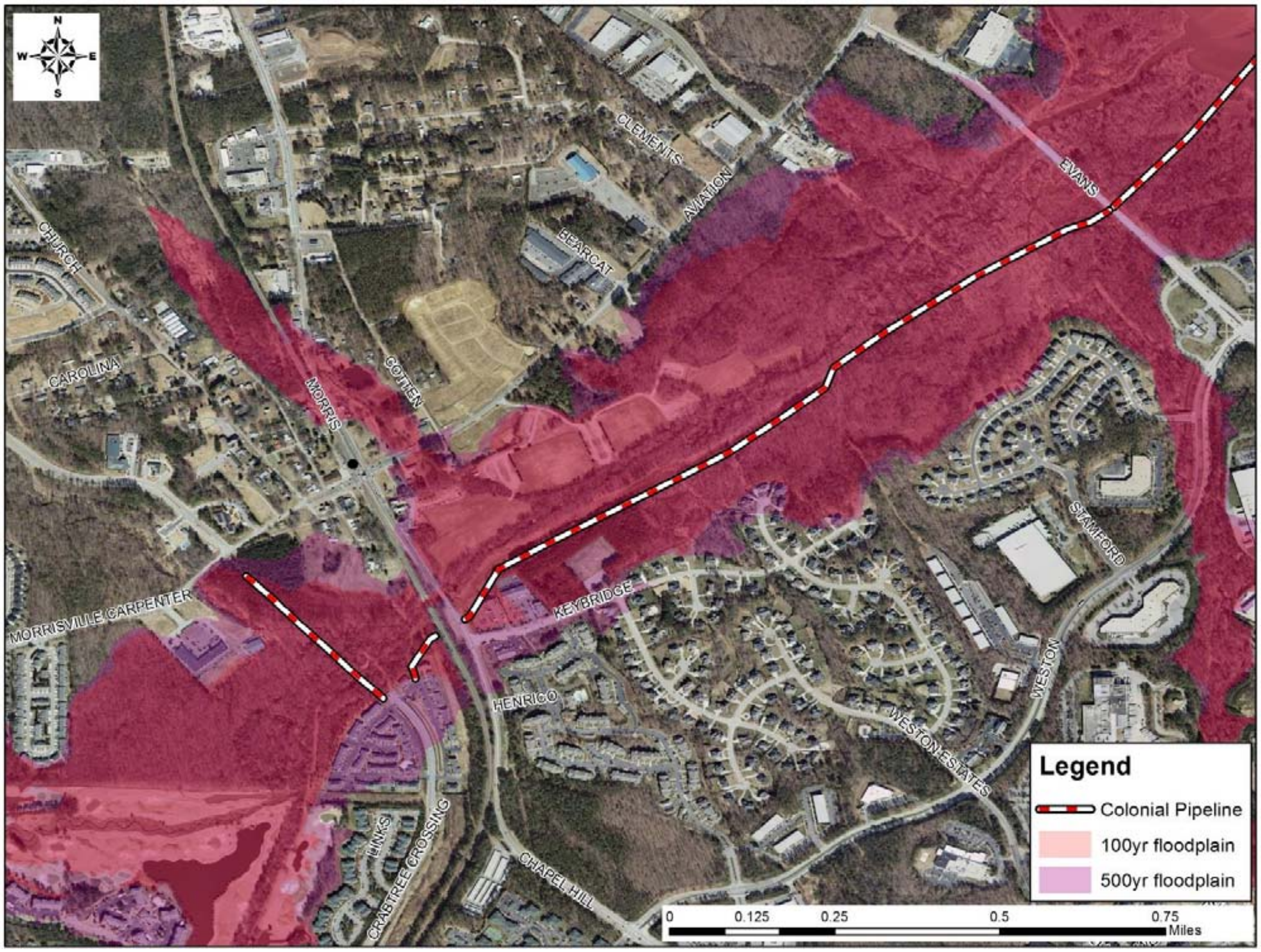
TABLE 5.54: CLASSIFICATION OF PROPERTY IMPACTED BY THE 1.0 AND 0.2 PERCENT ANNUAL CHANCE FLOOD

Code	Land Classification	Acres Impacted by 100-year Flood	Acres Impacted by 500-year Flood
A	AC-W/IMP	267.85	287.11
B	AC >10 Acres-Home Site	1,187.31	1,264.05
C	Commercial	1,210.27	1,430.99
D	Industrial	250.95	306.49
E	Exempt	20,361.70	21,242.41
F	Agricultural-Farm	4,707.99	5,003.75
G	Apartment	306.22	384.90
H	Historic Site	9.60	10.33
I	Homeowners Association	1,970.23	2,090.25
J	Cemetery	4.61	5.11
K	Retirement Home	2.09	2.09
M	Manufactured Home	115.28	125.27
N	Condominium	12.09	15.48
O	MA+Condo	46.85	61.60
P	Private Exempt	59.32	65.42
R	Residence -< 10 Acres-Home Site	2,756.90	3,242.25
S	State-Assessed	5,486.97	5,496.74
T	Mobile Home Park	189.67	210.32
U	Golf Course	895.10	972.44
V	Vacant	6,241.22	6,811.22
W	Water/Sewer System	34.14	39.57
Y	Floriculture-Farm	2,595.65	2,757.16
Z	Horticulture-Farm	81.66	87.26

Critical Infrastructure and Key Resources

Critical infrastructure and key resources (CIKR) within Wake County include assets, systems, and networks that are vital to the continued operation of government services. The incapacitation or destruction of these resources would have a debilitating effect on the county's security, economy, and/or public health. One CIKR that could be impacted by a 100-year or 500-year flood event are the Cardinal, Colonial, and Dixie pipeline systems. An example of a Colonial product (PRD) pipeline residing within floodplain area is shown in **Figure 5.18**, just northeast of Crabtree Lake.

FIGURE 5.18: COLONIAL PIPELINE IMPACTED BY 1.0 AND 0.2 PERCENT CHANCE ANNUAL FLOODPLAIN



Economy

There are a variety of economic impacts that could result from a large-scale flood event. According to a GIS-based spatial analysis of Wake County property, about 7,848 acres of agricultural land may be affected by a 500-year flood. The most major impact on soil that is covered by flood waters is the rapid depletion of oxygen, which is essential for plant growth and development. Secondly, flooding may modify nutrients within the soil either by leaching or changing their availability to the plant. Impact from submersion will vary with duration and temperature. The full extent of injury to seedlings would be determined by the current stage of development at the time of flooding, duration of the flood event, air and soil temperatures, and the presence of axillary buds.

Most research indicates that wheat can withstand water-logged soils for up to 24 hours without severe damage, but barley would not last as long under these conditions. When a small-grain crop such as wheat or barley survives flooding, recovery may be very slow and yield will be much less than normal. Corn is very sensitive to prolonged saturation prior to the fifth- or sixth-leaf stage; however, after the sixth-leaf stage, corn can survive approximately 2–4 days of flooded conditions; once the silting stage is reached, shallow flooding would not cause a noticeable amount of damage.

Environment

The fluctuation of water levels in a wetland, especially flood waters, supports the biological diversity of low-lying areas by releasing nutrients into the soil and germinating wetland flora. Flooding also offers some control of invasive water weeds.

Other Hazards

5.16 HAZARDOUS MATERIALS INCIDENTS

5.16.1 Background

Hazardous materials can be found in many forms and quantities that can potentially cause death; serious injury; long-lasting health effects; and damage to buildings, homes, and other property in varying degrees. Such materials are routinely used and stored in many homes and businesses and are also shipped daily on the nation's highways, railroads, waterways, and pipelines. This subsection on the hazardous material hazard is intended to provide a general overview of the hazard, and the threshold for identifying fixed and mobile sources of hazardous materials is limited to general information on rail, highway, and FEMA-identified fixed HAZMAT sites determined to be of greatest significance as appropriate for the purposes of this plan.

Hazardous material (HAZMAT) incidents can apply to fixed facilities as well as mobile, transportation-related accidents in the air, by rail, on the nation's highways, and on the water. Approximately 6,774 HAZMAT events occur each year, 5,517 of which are highway incidents, 991 are railroad incidents, and 266 are due to other causes.[30] In essence, HAZMAT incidents consist of solid, liquid, and/or gaseous contaminants that are released from fixed or mobile containers, whether by accident or by design as with an intentional terrorist attack. A HAZMAT incident can last hours to days, while some chemicals can be corrosive or otherwise damaging over longer periods of time. In addition to the primary release, explosions and/or fires can result from a release, and contaminants can be extended beyond the initial area by persons, vehicles, water, wind, and possibly wildlife as well.

HAZMAT incidents can also occur as a result of or in tandem with natural hazard events, such as floods, hurricanes, tornadoes, and earthquakes, which in addition to causing incidents can also hinder response efforts. In the case of Hurricane Floyd in September 1999, communities along the Eastern United States were faced with flooded junkyards, disturbed cemeteries, deceased livestock, floating propane tanks, uncontrolled fertilizer spills, and a variety of other environmental pollutants that caused widespread toxological concern.

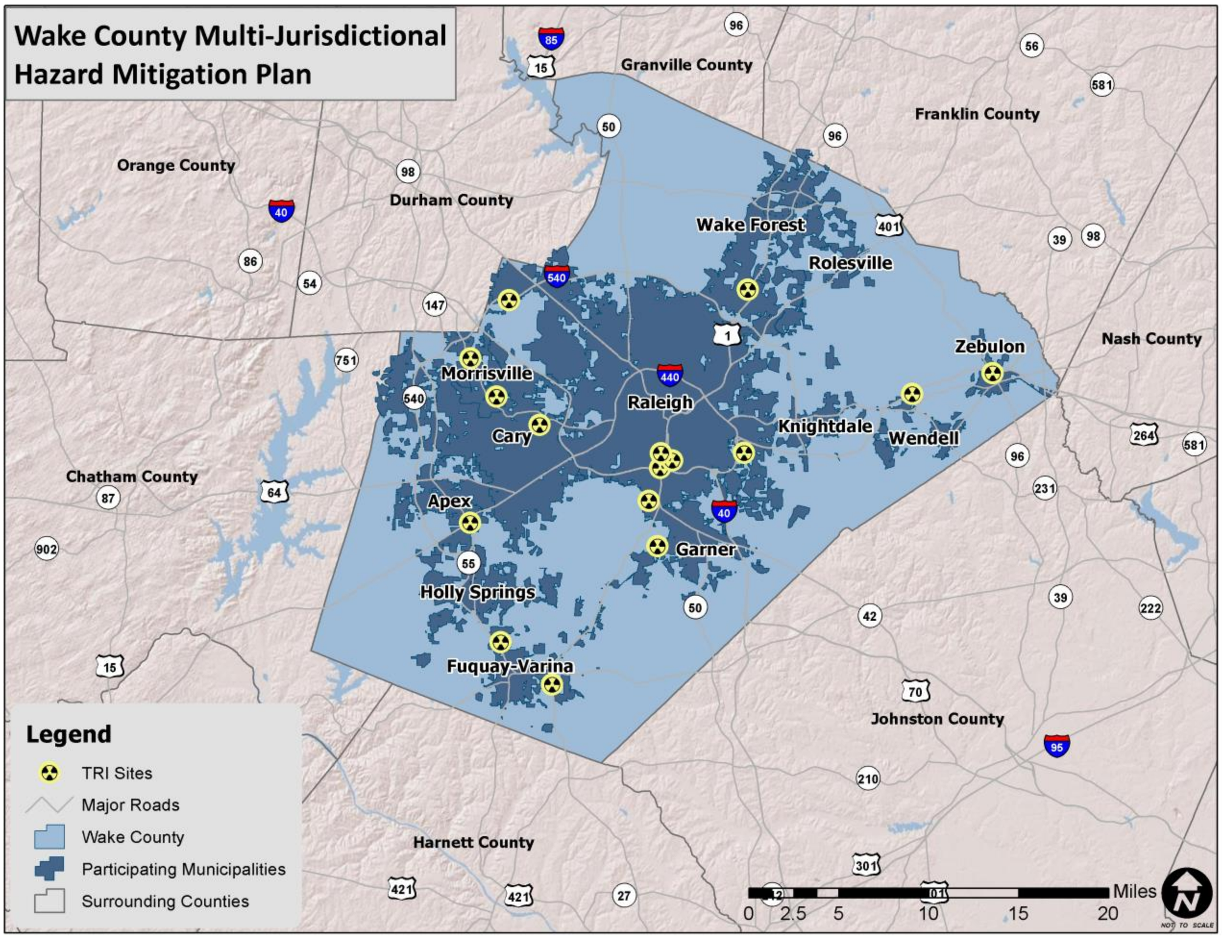
Hazardous material incidents can include the spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing into the environment of a hazardous material, but exclude: (1) any release which results in exposure to poisons solely within the workplace with respect to claims which such persons may assert against the employer of such persons; (2) emissions from the engine exhaust of a motor vehicle, rolling stock, aircraft, vessel or pipeline pumping station engine; (3) release of source, byproduct, or special nuclear material from a nuclear incident; and (4) the normal application of fertilizer.

[30] FEMA, 1997.

5.16.2 Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Wake County has twenty-nine TRI sites. These sites are shown in **Figure 5.19.**

FIGURE 5.19: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the region via roadways and rail. Many roads in the region are subject to hazardous material transport and all roads that permit hazardous material transport are considered potentially at risk to an incident.

5.16.3 Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" (highlighted in yellow in **Table 5.37** below) is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table 5.55 presents summary information on historic HAZMAT incidents reported in Wake County.

TABLE 5.55: SUMMARY OF HAZMAT INCIDENTS IN WAKE COUNTY

Location	Number of Occurrences	Deaths/ Injuries	Damages ($)
Apex	0	0/0	$0
Cary	1	0/0	$0
Fuquay-Varina	0	0/0	$0
Garner	0	0/0	$0
Holly Springs	0	0/0	$0
Knightdale	0	0/0	$0
Morrisville	31	0/0	$0
Raleigh	91	0/0	$0
Rolesville	0	0/0	$0
Wake Forest	0	0/0	$0
Wendell	1	0/0	$0
Zebulon	1	0/0	$0
Unincorporated Area	0	0/0	$0
WAKE COUNTY TOTAL	**125**	**0/0**	**$0**

TABLE 5.56: SUMMARY OF HAZMAT INCIDENTS IN WAKE COUNTY

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Wake County							
None reported							
Apex							
N/A	10/5/2006	APEX	Fixed facility	Yes	0/30	-	>50 gallons
Cary							
I-2000060136	5/25/2000	CARY	Highway	No	0/0	$0	20 LGA

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Fuquay-Varina							
None reported							
Garner							
None reported							
Holly Springs							
None reported							
Knightdale							
None reported							
Morrisville							
I-1980080433	8/1/1980	MORRISVILLE	Air	No	0/0	$0	1 LGA
I-1992080023	6/25/1992	MORRISVILLE	Highway	No	0/0	$0	1 LGA
I-1993110976	10/8/1993	MORRISVILLE	Air	No	0/0	$0	0.1875 SLB
I-1994041339	3/18/1994	MORRISVILLE	Highway	No	0/0	$0	0.132086 LGA
I-1994060939	5/10/1994	MORRISVILLE	Highway	No	0/0	$0	10 SLB
I-1994070600	6/14/1994	MORRISVILLE	Highway	No	0/0	$0	0.08375 LGA
I-1994101619	9/29/1994	MORRISVILLE	Highway	No	0/0	$0	2.5 LGA
I-1994120661	11/17/1994	MORRISVILLE	Highway	No	0/0	$0	0.1875 SLB
I-1997080070	7/17/1997	MORRISVILLE	Highway	No	0/0	$0	1 LGA
I-1997080773	8/5/1997	MORRISVILLE	Highway	No	0/0	$0	1 LGA
I-1999030620	2/17/1999	MORRISVILLE	Highway	No	0/0	$0	1 LGA
I-2000070193	6/18/2000	MORRISVILLE	Highway	No	0/0	$0	2.63 LGA
I-2000070205	6/25/2000	MORRISVILLE	Highway	No	0/0	$0	0.004688 LGA
I-2001030835	3/12/2001	MORRISVILLE	Highway	No	0/0	$0	0.046875 LGA
I-2002050797	4/11/2002	MORRISVILLE	Highway	No	0/0	$0	0.007813 LGA
I-2003060466	5/21/2003	MORRISVILLE	Highway	No	0/0	$0	0.007813 LGA
I-2004040070	2/13/2004	MORRISVILLE	Highway	No	0/0	$0	2 LGA
I-2004050082	4/2/2004	MORRISVILLE	Highway	No	0/0	$0	1 LGA
I-2005020957	2/1/2005	MORRISVILLE	Air	No	0/0	$0	0.26418 LGA
I-2005100167	8/10/2005	MORRISVILLE	Highway	No	0/0	$0	3 LGA
I-2006060230	5/22/2006	MORRISVILLE	Highway	No	0/2	$0	0.5 LGA
I-2006080263	7/24/2006	MORRISVILLE	Highway	No	0/0	$0	0.007812 LGA
I-2006091247	8/22/2006	MORRISVILLE	Highway	No	0/0	$0	1.125 LGA
I-2007061257	6/6/2007	MORRISVILLE	Highway	No	0/0	$0	0.5 LGA
E-2009010088	1/8/2009	MORRISVILLE	Air	No	0/0	$0	0.26418 LGA
I-2009020410	2/19/2009	MORRISVILLE	Highway	No	0/0	$0	1 LGA
X-2009060140	5/28/2009	MORRISVILLE	Highway	No	0/0	$0	0.5 LGA
I-2011020202	1/21/2011	MORRISVILLE	Highway	No	0/0	$0	2 SLB
I-2004040070	2/13/2004	MORRISVILLE	Highway	No	0/0	$0	1 LGA
I-2006091247	8/22/2006	MORRISVILLE	Highway	No	0/0	$0	4 LGA
I-2001030835	3/12/2001	MORRISVILLE	Highway	No	0/0	$0	0.26418 LGA
Raleigh							
I-1977080716	7/30/1977	RALEIGH	Rail	No	0/0	$0	75 LGA
I-1978110327	11/1/1978	RALEIGH	Highway	No	0/0	$0	0
I-1979100080	9/26/1979	RALEIGH	Highway	No	0/0	$0	0
I-1981010515	12/11/1980	RALEIGH	Highway	No	0/0	$0	0

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
I-1981060498	6/1/1981	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1981060461	6/5/1981	RALEIGH	Highway	No	0/0	$0	0
I-1981070578	6/29/1981	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1981070804	7/15/1981	RALEIGH	Highway	No	0/0	$0	0
I-1981100173	9/24/1981	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1982040236	3/31/1982	RALEIGH	Highway	No	0/0	$0	4 LGA
I-1983070353	7/13/1983	RALEIGH	Highway	No	0/0	$0	0
I-1983110081	10/12/1983	RALEIGH	Highway	No	0/0	$0	0
I-1984020005	1/27/1984	RALEIGH	Highway	No	0/0	$0	0.084 LGA
I-1984020007	1/31/1984	RALEIGH	Highway	No	0/0	$0	0.028 LGA
I-1984060124	5/29/1984	RALEIGH	Highway	No	0/0	$0	0.75 LGA
I-1984070014	6/20/1984	RALEIGH	Highway	No	0/0	$0	0.75 LGA
I-1984080225	7/30/1984	RALEIGH	Highway	No	0/0	$0	0.028 LGA
I-1984100136	9/20/1984	RALEIGH	Highway	No	0/0	$0	2 LGA
I-1984100442	10/5/1984	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1984110124	10/26/1984	RALEIGH	Highway	No	0/0	$0	0.025 LGA
I-1985010128	12/18/1984	RALEIGH	Highway	No	0/0	$0	0.063 LGA
I-1985020178	1/25/1985	RALEIGH	Highway	No	0/1	$0	0.063 LGA
I-1985020241	2/1/1985	RALEIGH	Highway	No	0/0	$0	6 LGA
I-1985030198	2/26/1985	RALEIGH	Highway	No	0/0	$0	2 LGA
I-1985030265	3/4/1985	RALEIGH	Highway	No	0/0	$0	0.25 LGA
I-1985050360	5/7/1985	RALEIGH	Highway	No	0/0	$0	0.12 LGA
I-1985060205	5/29/1985	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1985100019	9/16/1985	RALEIGH	Highway	No	0/0	$0	11.03 SLB
I-1986030006	2/17/1986	RALEIGH	Highway	No	0/0	$0	0.5 LGA
I-1986070259	6/26/1986	RALEIGH	Highway	No	0/0	$0	2.5 LGA
I-1986080269	7/29/1986	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1986100005	9/16/1986	RALEIGH	Highway	No	0/0	$0	0.1 LGA
I-1987070563	7/1/1987	RALEIGH	Highway	No	0/0	$0	0
I-1987100297	9/24/1987	RALEIGH	Highway	No	0/0	$0	3.63 LGA
I-1987100321	10/6/1987	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1987100343	10/7/1987	RALEIGH	Highway	No	0/0	$0	5 LGA
I-1988010146	12/18/1987	RALEIGH	Highway	No	0/0	$0	0.028 LGA
I-1988010148	12/22/1987	RALEIGH	Highway	No	0/0	$0	0.25 LGA
I-1988080461	7/21/1988	RALEIGH	Highway	No	0/0	$0	30 LGA
I-1989020160	1/31/1989	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1990030107	1/26/1990	RALEIGH	Air	No	0/0	$0	0
I-1990030232	2/20/1990	RALEIGH	Highway	No	0/0	$0	5 LGA
I-1990120159	10/25/1990	RALEIGH	Highway	No	0/0	$0	50 LGA
I-1993081588	8/2/1993	RALEIGH	Air	No	0/0	$0	0.039063 LGA
I-1993081357	8/2/1993	RALEIGH	Highway	No	0/0	$0	0
I-1993100673	8/9/1993	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1994080300	7/21/1994	RALEIGH	Rail	Yes	0/0	$0	40000 SLB
I-1994101389	10/18/1994	RALEIGH	Highway	No	0/0	$0	50 LGA
I-1995100985	4/14/1995	RALEIGH	Highway	No	0/0	$0	1.056688 LGA
I-1995071497	4/28/1995	RALEIGH	Highway	No	0/0	$0	0.03125 LGA

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
I-1995071494	5/8/1995	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1995071554	5/25/1995	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1995101404	6/27/1995	RALEIGH	Highway	No	0/0	$0	0.25 LGA
I-1995071499	7/12/1995	RALEIGH	Highway	No	0/0	$0	0.015625 LGA
I-1995120430	11/1/1995	RALEIGH	Highway	No	0/0	$0	0.015625 LGA
I-1996020469	1/16/1996	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1996071223	7/23/1996	RALEIGH	Highway	No	0/0	$0	0.023438 LGA
I-1996080443	7/30/1996	RALEIGH	Highway	No	0/0	$0	0.078125 LGA
I-1996080442	8/5/1996	RALEIGH	Highway	No	0/0	$0	0.25 LGA
I-1996090297	8/29/1996	RALEIGH	Highway	No	0/0	$0	0.007813 LGA
I-1996110026	10/29/1996	RALEIGH	Air	No	0/0	$0	0.007925 LGA
I-1996120028	11/25/1996	RALEIGH	Highway	No	0/0	$0	10 SLB
I-1997040453	3/4/1997	RALEIGH	Highway	No	0/0	$0	0.125 LGA
I-1997040455	3/11/1997	RALEIGH	Highway	No	0/0	$0	0.125 LGA
I-1997040454	3/11/1997	RALEIGH	Highway	No	0/0	$0	0.125 LGA
I-1997100264	9/24/1997	RALEIGH	Air	No	0/0	$0	0
I-1999100328	9/9/1999	RALEIGH	Highway	No	0/0	$0	4 LGA
I-2000121256	7/17/2000	RALEIGH	Highway	No	0/0	$0	0.015625 LGA
I-2000110296	7/17/2000	RALEIGH	Highway	No	0/0	$0	1 LGA
I-2000091202	9/7/2000	RALEIGH	Air	No	0/0	$0	0
I-2001081264	8/14/2001	RALEIGH	Air	No	0/0	$0	0.007925 LGA
I-2002021296	12/4/2001	RALEIGH	Highway	No	0/0	$0	1 LGA
I-2002100659	9/21/2002	RALEIGH	Air	No	0/0	$0	0.528344 LGA
I-2003020893	2/7/2003	RALEIGH	Highway	No	0/0	$0	0.000011 SLB
I-2003040684	4/1/2003	RALEIGH	Highway	No	0/0	$0	1.41 LGA
I-2003080356	7/21/2003	RALEIGH	Highway	No	0/0	$0	1.5 LGA
I-2004061482	6/11/2004	RALEIGH	Highway	No	0/0	$0	2 SLB
I-2004070869	6/23/2004	RALEIGH	Highway	No	0/0	$0	0.000654 LGA
I-2004071381	7/8/2004	RALEIGH	Highway	No	0/0	$0	0.007813 LGA
I-2004100076	9/24/2004	RALEIGH	Highway	No	0/0	$0	0.132086 LGA
I-2005050548	5/11/2005	RALEIGH	Highway	No	0/0	$0	0.25 LGA
I-2006050673	4/17/2006	RALEIGH	Highway	No	0/0	$0	0.007812 LGA
I-2006060671	5/16/2006	RALEIGH	Highway	No	0/0	$0	0.015625 LGA
I-2006090269	7/27/2006	RALEIGH	Highway	No	0/0	$0	0.023438 LGA
I-2007051141	4/26/2007	RALEIGH	Highway	No	0/0	$0	0.5 LGA
I-2007090012	8/1/2007	RALEIGH	Highway	No	0/0	$0	2 LGA
I-2007100362	10/4/2007	RALEIGH	Highway	No	0/0	$0	0.125 LGA
E-2008050190	4/25/2008	RALEIGH	Rail	No	0/0	$0	5 LGA
I-2008090672	8/8/2008	RALEIGH	Highway	No	0/0	$0	25 LGA
I-2011070414	7/7/2011	RALEIGH	Highway	No	0/0	$0	0.066045 LGA
E-2013040047	3/15/2013	RALEIGH	Highway	No	0/0	$0	8 SLB
Rolesville							
None reported							
Wake Forest							
None reported							
Wendell							

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
I-1982080279	8/3/1982	WENDELL	Highway	No	0/0	$0	1 LGA
Zebulon							
I-2004090250	4/1/2004	ZEBULON	Highway	No	0/0	$0	0.125 LGA

Source: USDOT PHMSA

5.16.4 Probability of Future Occurrence

Given the location of twenty-nine toxic release inventory sites in Wake County and several serious roadway incidents, it is likely (10-100 percent probability) that a hazardous material incident may occur in the county, though a major incident is less likely. County and municipal officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

5.16.5 Consequence Analysis

People (The Public and Public Confidence)
In the case of a HazMat release, a person's vulnerability is largely determined by his or her proximity to dangerous sites and the type(s) of HazMat being stored or used in daily processes. Hazardous materials incidents often have a strong impact on public confidence as the impacts of this type of event can cause serious and sometimes gruesome effects on people. Since hazardous materials are man-made, there is also often some understanding on the part of the public that they can be more easily prevented than natural disasters.

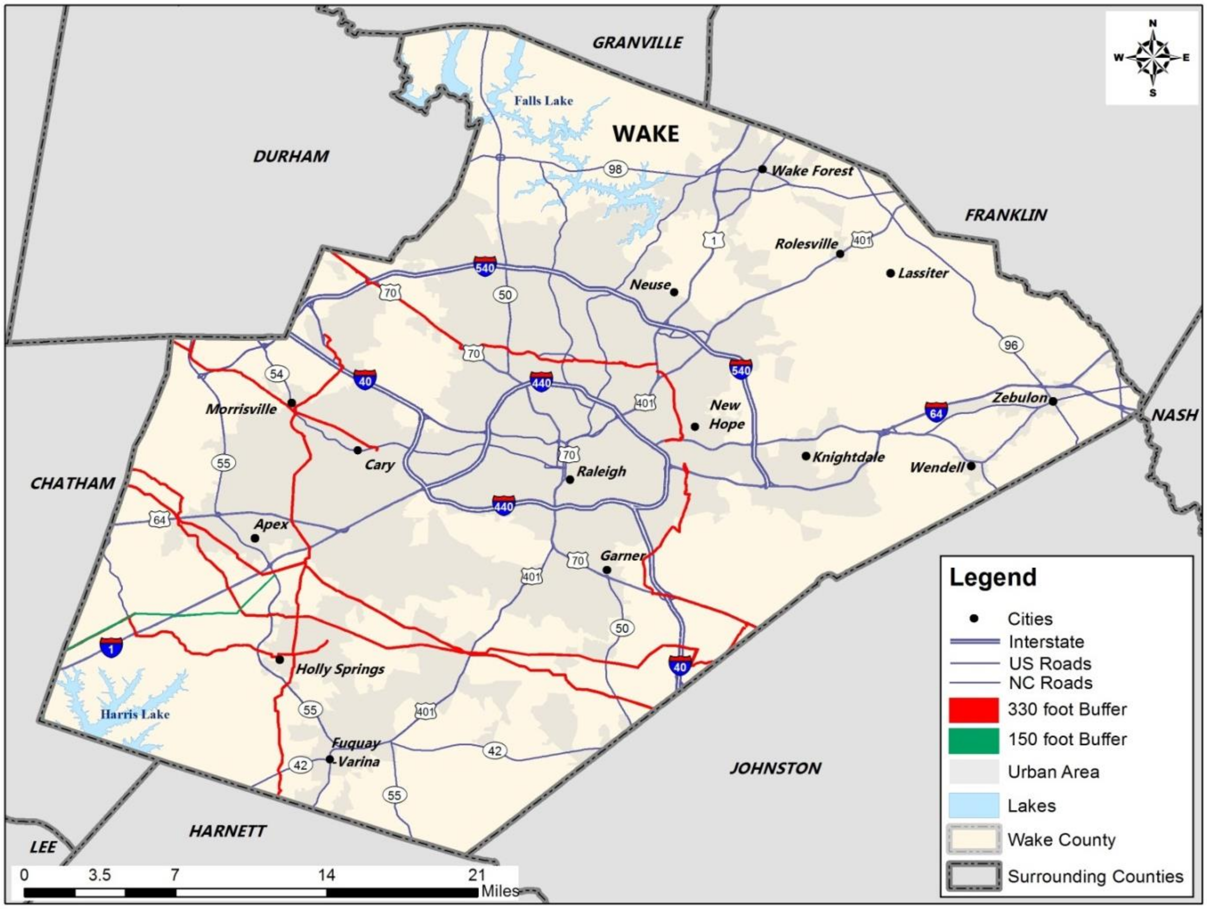
Responders
One of the challenges for responders in a hazardous materials incident is preventing the impact that the incident has on their personal health and well-being. Responders must balance their responsibilities to control the incident with their responsibilities to protect themselves.

Continuity of Operations
There could be an impact to continuity of operations in the event of a hazardous materials spill, although most HazMat events are relatively small-scale, there is always a potential for a large event that would disrupt the normal flow of operations.

Built Environment (Property, Facilities, and Infrastructure)
Pipelines
According to a State-level hazardous materials study conducted in 2011, highly volatile liquids (HVLs), other non-volatile liquid products (PRDs), and natural gas are transported by pipeline in the county. Based on the Emergency Response Guide,[31] the isolation buffer zone for HVL pipelines should be 150 feet, and the isolation buffer for PRD and natural gas pipelines should be 330 feet. To analyze the area around each pipeline that could be impacted by a release of these materials, a buffer was created for each pipeline segment within the county based on the distances mentioned above. **Figure 5.20**depicts these buffer zones in relation to urban areas and roadways in the county.

[31] U.S. Department of Transportation. (2008). *Emergency Response Guide*.

FIGURE 5.20: ISOLATION BUFFER ZONES FOR PIPELINES IN WAKE COUNTY



For additional analysis of Hazardous Materials incidents and their impact on the built environment, please see *Section 6: Hazard Vulnerability* which describes impacts on property from fixed HazMat sites and a mobile HazMat analysis.

Economy

Myriad economic impacts may result from a HazMat release within the county. Many of these factors could not be calculated from historic incidents or predicted, but they are listed here for consideration.

- Property damage from an explosion
- Emergency protective actions
- HazMat response
- Debris removal and disposition
- Repair to facility, critical facilities, and vulnerable facilities
- Environmental remediation

Environment

The environmental consequences of a HazMat release vary considerably by substance. Under the Emergency Planning and Community Right to Know Act (EPCRA) of 1986, the federal government has designated several hundred chemicals as "extremely hazardous substances" based on their acute lethal toxicity. Under the law, releases of EHS chemicals trigger reporting requirements to local, state, and federal authorities. **Table 5.56** shows the hazard form and major uses for each EHS chemical reported in Wake County.

Table 5.57: Hazard Form and Major Uses of Extremely Hazardous Substances

Chemicals	Isolation Distance	Environmental Concern	Hazard form/ Major use(s)
Aldicarb	75 feet	Acute and persistent	Toxic solid/pesticide
Anhydrous ammonia	500 feet	Acute but transient	Toxic gas/refrigerant and fertilizer
Aniline	150 feet	Acute but transient	Toxic liquid/feedstock for pharmaceutical production
Bromadiolone	75 feet	Acute and persistent	Toxic solid/rodenticide
Chlorine	2,000 feet	Acute but transient	Toxic gas/disinfectant
Chlorophacinone	75 feet	Acute and persistent	Toxic solid/rodenticide
Cyclohexylamine	150 feet	Acute but transient	Toxic liquid/feedstock for pharmaceutical production
Dimethyl 4-(methylthio)phenyl ester	150 feet	Acute and persistent	Toxic liquid/pesticide
Diphacinone	75 feet	Acute and persistent	Toxic solid/rodenticide
Disulfoton	75 feet	Acute and persistent	Toxic solid/pesticide
Ethylene oxide	500 feet	Acute but transient	Toxic gas/feedstock for chemical production and disinfectant
Fenamiphos	150 feet	Acute and persistent	Toxic liquid/pesticide
Formaldehyde	150 feet	Acute but transient	Toxic liquid/feedstock for adhesive production
Hydrazine	150 feet	Acute but transient	Toxic liquid/water treatment and chemical production
Hydrogen chloride (gas only)	200 feet	Acute but transient	Toxic gas/chemical production
Hydrogen peroxide (conc >52%)	150 feet	Acute but transient	Reactive liquid/wastewater treatment and bleaching
Nitric acid	500 feet	Acute but transient	Corrosive and toxic liquid/feedstock for chemical production and metal cleaning
Nitric oxide	330 feet	Acute but transient	Toxic gas/feedstock for chemical production
Nitrobenzene	150 feet	Acute and persistent	Toxic liquid/feedstock for pharmaceutical production
Paraquat dichloride	150 feet	Acute and persistent	Toxic liquid/herbicide
Sulfuric acid	150 feet	Acute but transient	Corrosive liquid/batteries, and feedstock chemical and industrial production
Vinyl acetate monomer	150 feet	Acute but transient	Toxic and flammable liquid/feedstock for chemical production and glue

5.17 WILDFIRE

5.17.1 Background

A wildfire is any outdoor fire (i.e. grassland, forest, brush land) that is not under control, supervised, or prescribed.[32] Wildfires are part of the natural management of forest ecosystems, but may also be caused by human factors.

Nationally, over 80 percent of forest fires are started by negligent human behavior such as smoking in wooded areas or improperly extinguishing campfires. The second most common cause for wildfire is lightning. In North Carolina, a majority of fires are caused by debris burning.

There are three classes of wildland fires: surface fire, ground fire, and crown fire. A surface fire is the most common of these three classes and burns along the floor of a forest, moving slowly and killing or damaging trees. A ground fire (muck fire) is usually started by lightning or human carelessness and burns on or below the forest floor. Crown fires spread rapidly by wind and move quickly by jumping along the tops of trees. Wildfires are usually signaled by dense smoke that fills the area for miles around.

Wildfire probability depends on local weather conditions, outdoor activities such as camping, debris burning, and construction, and the degree of public cooperation with fire prevention measures. Drought conditions and other natural hazards (such as tornadoes, hurricanes, etc.) increase the probability of wildfires by producing fuel in both urban and rural settings.

Many individual homes and cabins, subdivisions, resorts, recreational areas, organizational camps, businesses, and industries are located within high wildfire hazard areas. Furthermore, the increasing demand for outdoor recreation places more people in wildlands during holidays, weekends, and vacation periods. Unfortunately, wildland residents and visitors are rarely educated or prepared for wildfire events that can sweep through the brush and timber and destroy property within minutes.

Wildfires can result in severe economic losses as well. Businesses that depend on timber, such as paper mills and lumber companies, experience losses that are often passed along to consumers through higher prices and sometimes jobs are lost. The high cost of responding to and recovering from wildfires can deplete state resources and increase insurance rates. The economic impact of wildfires can also be felt in the tourism industry if roads and tourist attractions are closed due to health and safety concerns.

State and local governments can impose fire safety regulations on home sites and developments to help curb wildfire. Land treatment measures such as fire access roads, water storage, helipads, safety zones, buffers, firebreaks, fuel breaks, and fuel management can be designed as part of an overall fire defense system to aid in fire control. Fuel management, prescribed burning, and cooperative land management planning can also be encouraged to reduce fire hazards.

[32] Prescription burning, or "controlled burn," undertaken by land management agencies is the process of igniting fires under selected conditions, in accordance with strict parameters.

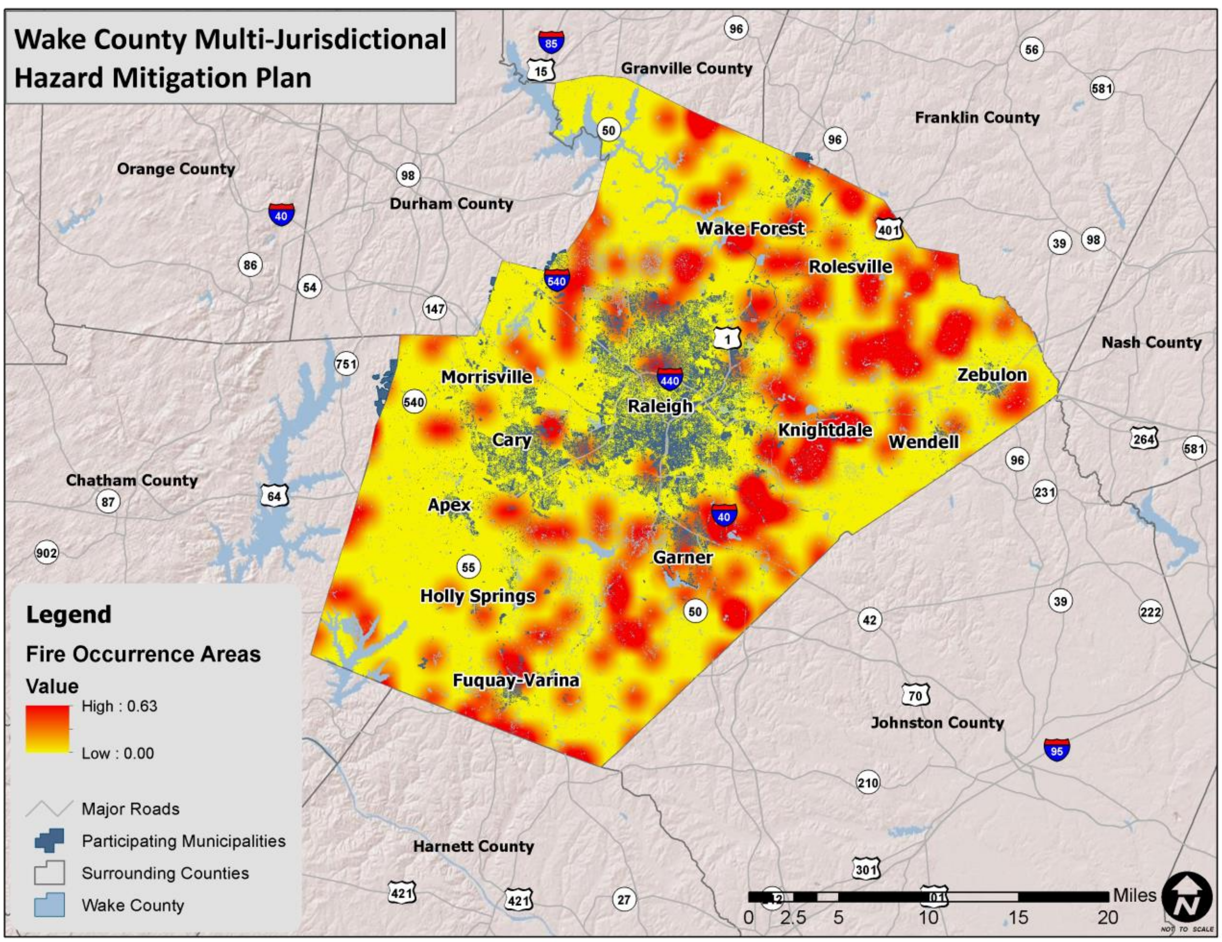
5.17.2 Location and Spatial Extent

The entire county is at risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas. Many areas within the Wake County are highly urbanized, reducing the amount forested area and thus the potential for wildfire to occur. The Fire Occurrence Areas in the figure below give an indication of historic locations impacted. Although it should be noted that the scale is relative to other areas of the county and does not necessarily indicate a high risk when compared to other regions of the state or country.

5.17.3 Historical Occurrences

Figure 5.21 shows the Fire Occurrence Areas (FOA) in Wake County based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. As indicated in this figure, the highest level reached in the county is less than 1, which indicates a very sparse history of wildfires in the county.

FIGURE 5.21: HISTORIC WILDFIRE EVENTS IN WAKE COUNTY



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of roughly 15wildfires annually which burn a combined 98 acres, on average. The data indicates that most of these fires are small, averaging six acres per fire. **Table 5.57** provides a summary table for wildfire occurrences in Wake County. **Table 5.58** lists the number of reported wildfire occurrences in the participating counties between the years 2003 and 2012.

TABLE 5.58: SUMMARY TABLE OF ANNUAL WILDFIRE OCCURRENCES (2003-2012)*

	Wake County
Average Number of Fires per year	15.5
Average Number of Acres Burned per year	98.2
Average Number of Acres Burned per fire	6

TABLE 5.59: HISTORICAL WILDFIRE OCCURRENCES IN WAKE COUNTY

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

5.17.4 Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Wake County. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Wake County for future wildfire events is possible (a 1 to 10 percent annual probability).

5.17.5 Consequence Analysis

People (The Public and Public Confidence)

There are a number of potential losses from a wildland fire in Wake County. Potential losses include human life, structures, and natural resources. Health hazards from smoke caused by wildland fires within or outside the county can include breathing difficulties and worsening of chronic breathing and/or cardiovascular disease. Smoke and air pollution pose a risk for children, the elderly, and those with respiratory and cardiovascular problems. First responders are also at risk for exposure to dangers from the initial incident and after-effects such as smoke inhalation and/or heat stroke. Wildfire tends to create some issues with public confidence because of the very visible impacts that the fire has on the community.

Responders

Responders are often at great risk when addressing a wildfire, especially firefighters who are responsible for putting out the blaze. All response personnel are potentially at risk when dealing with a wildfire and often changing winds and a number of other factors can cause a fire to spread rapidly. Although much of Wake County has been urbanized and is not at a high risk to wildfire, the more rural areas that are located in the wildland urban interface may require response personnel to be ready to act.

Continuity of Operations

Since wildfire often moves quickly and can affect infrastructure that is important to maintaining continuity of operations, there is some level of concern for maintaining continuity. However, operations in Wake County, which are generally run from urbanized areas, will probably not be impacted in a major way.

Built Environment (Property, Facilities, and Infrastructure)

The WUI area is composed of both interface and intermix communities where structures and other human developments meet or intermingle with undeveloped wildland or vegetative fuel.[33] In both interface and intermix communities, housing must meet or exceed a minimum density of 1 structure per 40 acres (16 hectares [ha]). Intermix communities are places where housing and vegetation intermingle and vegetation is continuous with more than 50 percent vegetation in areas with more than 1 house per 16 ha.[34] Interface communities are areas with housing in the vicinity of contiguous vegetation that have more than 1 house per 40 acres, have less than 50 percent vegetation, and are within 1.5 miles of an area (made up of one or more contiguous census blocks) over 1,325 acres (500 ha) that is more than 75 percent vegetated.[35] The minimum size limit ensures that areas surrounding small urban parks are not classified as interface WUI.

Table 5.59 shows WUI areas by land classification in Wake County. In Wake County, 28.9 percent of land is classified as intermix areas, and 22.9 percent of land is classified as interface areas.

Table 5.60: WAKE COUNTY WILDLAND URBAN INTERFACE LAND CLASSIFICATION

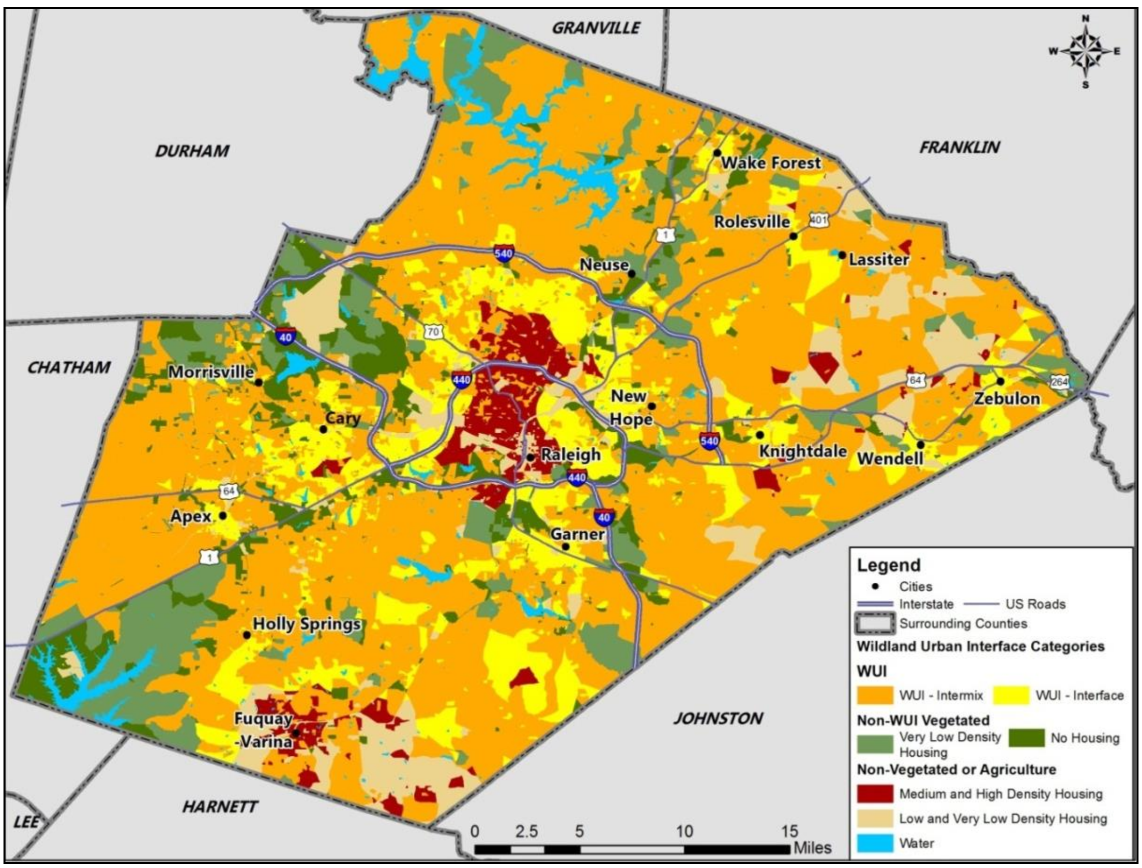
Land Classification	Acres	Percentage of Total
High Density Interface	711	5.98%
High Density Intermix	550	4.63%
High Density No Vegetation	570	4.79%
Low Density Interface	259	2.18%
Low Density Intermix	904	7.60%
Low Density No Vegetation	167	1.40%
Medium Density Interface	1753	14.74%
Medium Density Intermix	1982	16.67%

[33] *Ibid.*
[34] *Ibid.*
[35] *Ibid.*

Land Classification	Acres	Percentage of Total
Medium Density No Vegetation	800	6.73%
Uninhabited No Vegetation	1678	14.11%
Uninhabited Vegetation	1676	14.09%
Very Low Density No Vegetation	35	0.29%
Very Low Density Vegetation	182	1.53%
Water	624	5.25%
Total	11891	

Figure 5.22shows the spatial location of the WUI and intermix areas within the county in relation to developed areas. Interface and intermix areas appear evenly dispersed throughout the county. A significant portion of the WUI interface area is located around the medium- and high-density housing areas located inside the beltline and in sections of north Raleigh. The WUI and intermix area is dispersed throughout Wake County, primarily outside the beltline.

FIGURE 5.22: WAKE COUNTY WILDLAND URBAN INTERFACE AND INTERMIX AREA



Wildland fires have the potential to substantially burn forested areas as well as private residences. Damage and destruction to State, county, private, and municipal structures and facilities are major losses that are attributed to wildland fires. Private residences and communities that are located within the WUI are particularly susceptible to the threat. Population increases in North Carolina's WUI areas, for example, can create significant challenges for firefighters and residents.

Many new homes are constructed without considering community wildland fire planning. This creates neighborhoods with limited accessibility, flammable building construction, and landscaping. A lack of firewise planning can also greatly increase the probability of a wildland fire occurrence with more homes and emergency personnel being threatened.

Impacts to agricultural crops are other direct property losses that Wake County could face in the event of a wildland fire. Some structural losses that might result include private property. These include business properties and homes, vehicles, and livestock. Damage to capital goods and equipment as well as evacuation expenses and other losses are directly related to fire and smoke damage. Additional potential losses include building and landscape maintenance expenses, firefighting equipment purchases, and fire-related business closures. Additional post-fire losses include cleanup, rehabilitation and repair expenses, equipment and capital goods replacement, drinking water pollution, smoke damage, deflated real estate values, and an increase in fire insurance premiums.

Economy

Given the fact that some homes, businesses, and infrastructure are located in areas that could be impacted by wildfire, there could be some significant economic impacts of a wildfire in Wake County. If homes or businesses are burned, the cost of rebuilding could be substantial.

Environment

Wildland fires have the potential to damage or destroy forage on grazing lands, secondary forest products destruction, and/or degradation and loss of wildlife habitat on public lands. On private lands, vegetation losses could include agricultural crops that are either burned or impacted by wildland fire smoke. Indirect losses could include loss of growing stock as well as irrigation systems. Another potential loss includes damage and destruction to a wide variety of common or protected habitats in Wake County.

Additional factors that contribute to wildland fire susceptibility in Wake County include long growing seasons with frequent rainfall and wind, which can significantly affect vegetation growth.

5.18 NUCLEAR ACCIDENT

5.18.1 Background

A nuclear and radiation accident is defined by the International Atomic Energy Agency as “an event that has led to significant consequences to people, the environment or the facility. Often, this type of incident results from damage to the reactor core of a nuclear power plant which can release radioactivity into the environment. The degree of exposure from nuclear accidents has varied from serious to catastrophic.

By some estimates, over 50 percent of nuclear accidents that have ever occurred were in the United States.[36] However, it is also important to note that generally, nuclear accidents are a rare occurrence. Many incidents are extremely well known due to their large-scale impact and serious effects on people and the environment.

[36] Benjamin K. Sovacool. A Critical Evaluation of Nuclear Power and Renewable Electricity in Asia *Journal of Contemporary Asia*, Vol. 40, No. 3, August 2010, pp. 393–400.

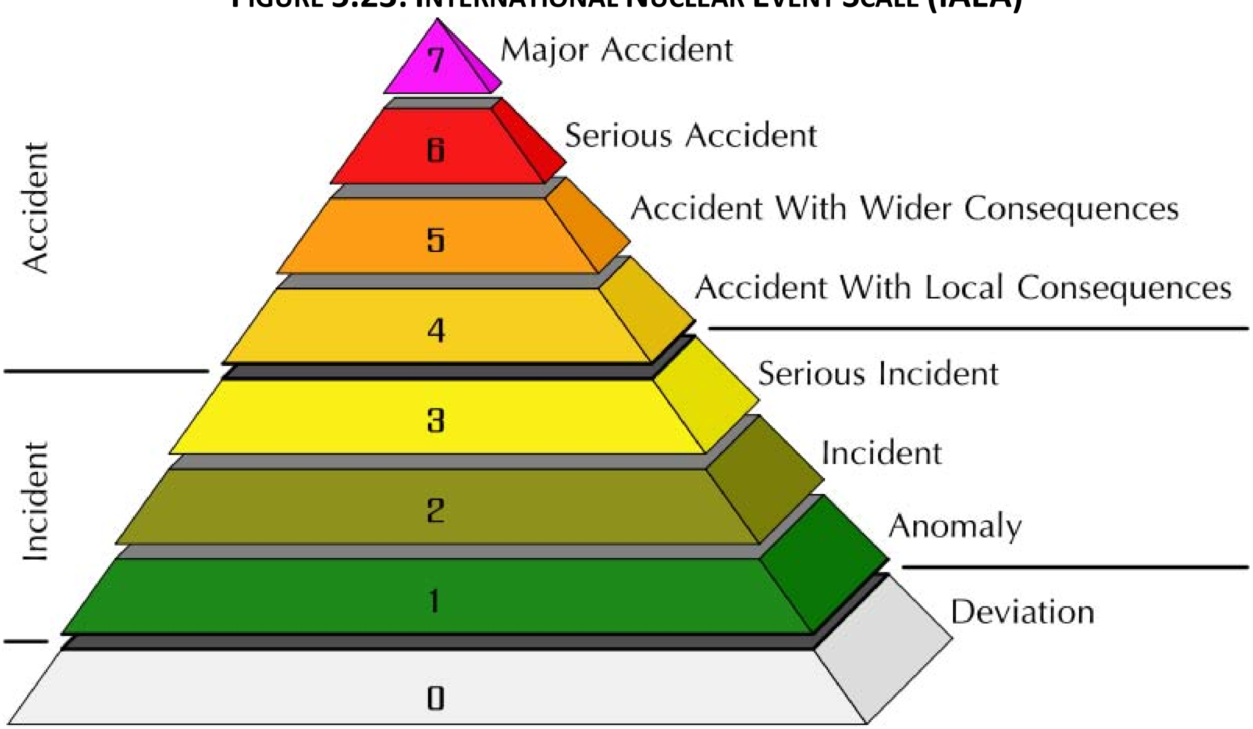
One of the most notorious accidents in the United States was the Three Mile Island accident which occurred in 1979 and released small amounts of radioactive gases and iodine into the environment. Although no deaths have been directly attributed to the accident, it invoked a strong public reaction and demonstrated the potential dangers associated with nuclear power generation.

Shearon Harris Nuclear Station, which is located in southwest Wake County, is a 2,948 megawatt power plant that began commercial operation in 1987. Its reactor is a pressurized water reactor and the plant operates with a very high level of security. This is the location from which the most catastrophic nuclear accident might occur in Wake County and will be the focal point of the nuclear analysis in this plan. However, it should also be noted that there is a 1 megawatt PULSTAR reactor located on North Carolina State University's campus in downtown Raleigh. Although its impacts would potentially be less far-reaching than Shearon Harris' in the event of an accident, it should still be noted that the effects could be extremely detrimental, especially to citizens and property within Raleigh.

5.18.2 Location and Spatial Extent

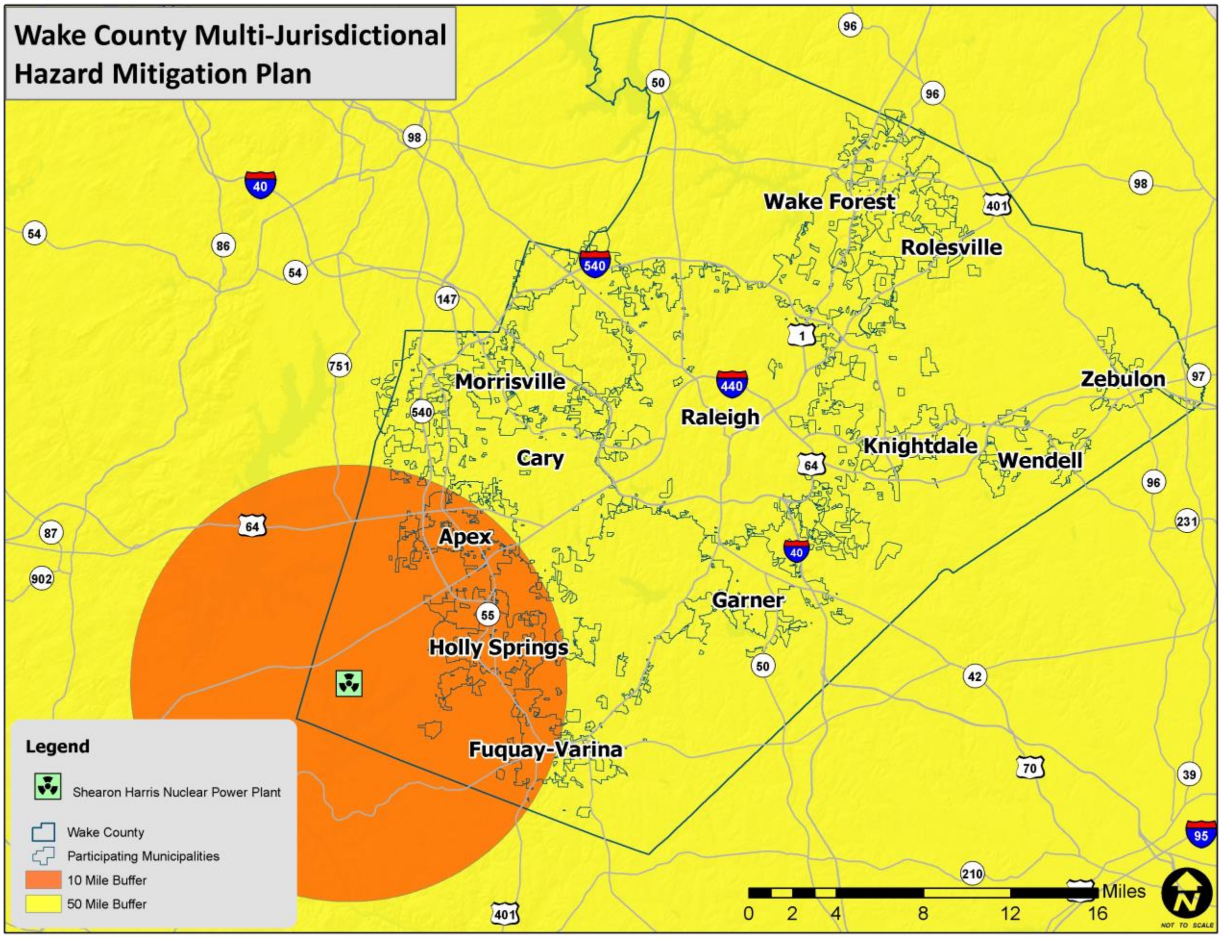
The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station. The International Atomic Energy Association has developed a scale called the International Nuclear and Radiological Event Scale (INES) which provides a quantitative means of assessing the extent of a nuclear event. This scale, like the MMI used for earthquakes, is logarithmic which means that each increasing level on the scale represents an event 10 times more severe than the previous level (**Figure 5.23**).

FIGURE 5.23: INTERNATIONAL NUCLEAR EVENT SCALE (IAEA)



The Nuclear Regulatory Commission defines two emergency planning zones around nuclear plants. Areas located within 10 miles of the station are considered to be within the zone of highest risk to a nuclear incident and this radius is the designated evacuation radius recommended by the Nuclear Regulatory Commission (**Figure 5.24**). Within the 10 mile zone, the primary concern is exposure to and inhalation of radioactive contamination. The most concerning effects in the secondary 50 mile zone are related to ingestion of food and liquids that may have been contaminated. All areas of the county that are not located within the 10 mile radius are located within this 50 mile radius that is still considered to be at risk from a nuclear incident.

FIGURE 5.24: SHEARON HARRIS NUCLEAR POWER STATION INCIDENT HAZARD ZONES



Source: International Atomic Energy Agency

5.18.3 Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 “Alerts” and 28 “Notice of Unusual Events” since 1986, which are shown in **Table 5.60**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table 5.61: Shearon Harris Emergency Declaration History

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on “B” Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of “A” Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - “B” diesel generator was being worked on; in accordance with test procedures, “A” diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).

Emergency Declaration	Date	Description
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported "Notice of Unusual Events" since 1986, which is shown in **Table 5.61**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table 5.62: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

5.18.4 Probability of Future Occurrences

A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

5.18.5 Consequence Analysis

People (The Public and Public Confidence)

Evacuation time Estimate for Permanent Residents

Table 5.62 shows the estimate of permanent residents from the most recent Evacuation Time Estimate (ETE) along with the associated population change for Wake County subzones A through G. Subzone A is the immediate area surrounding the facility and zones ascend upward alphabetically as distance from the plant increases.

The estimate of permanent residents in 2010 is not available through the ETE; however, 2000 Census Block data and 2010 Census Block data are available for comparison. Total population in the Wake County EPZ (subzones A–G) was 49,889 in 2000 and 92,667 in 2010. The annual population growth rate for Wake County based on this 10-year period was calculated as 25 percent ([92,667-49,889]/49889*100/10 years equals 8.57 percent).

Table 5.63: ETE Permanent Residents in Wake County

Sub-Zone	2000 Population	2010 Population
A	143	121
B	1,113	1,180
C	331	2,085
D	258	243
E	26,146	45,267
F	10,764	22,348
G	12,324	21,423
Total	51,079	92,667
Population Growth: 8.57%		

Population Characteristics

Table 5.63 outlines the population characteristics for each EPZ subzone (A–G) that falls within Wake County against the total population within the entire county. Population characteristics were collected from the 2010 U.S. Census at the block level and sorted by EPZ subzone. Approximately 30.83 percent of the total population in the 7 subzones combined comprises the total population in Wake County. Of these 7 subzones, 48.8 percent of the population falls within subzone E; while 24.1 percent of the population falls within subzone F.

Subzone E has the highest concentration of people in the 65 and older age group (42.8 percent) as well as the 18–64 age group (49.1 percent). Another insight that can be gleamed from this table is that subzone E has the highest number of people in the 18 and under age bracket of the 7 subzones combined (49.6 percent).

Table 5.64: Age Characteristics of Impacted Population

Sub-Zone	Population under Age 18	Population 18–64	Population 65 and over
A	19	73	29
B	276	749	155
C	731	1,268	86
D	67	150	26
E	14,744	27,702	2,821
F	7,659	13,453	1,236
G	6,227	12,963	2,233
Subzone (A–G) Total Population	29,723	56,358	6,586
Wake County Total Population	234,613	589,831	76,549
Percent of Total	12.67%	9.55%	8.60%

The number and characteristics of people that would be impacted by radiological release by subzone is shown in **Table 5.64**.

Table 5.65: AGE, SEX, AND RACE OF IMPACTED POPULATION

Subzone	White Only	Black or African American Only	American Indian or Alaskan Native Only	Asian Only	Native Hawaiian or Pacific Islander Only	Other Race	Number of People with Hispanic Origins
A	67	37	3	0	0	14	22
B	997	88	11	14	4	19	44
C	1712	255	3	39	1	17	123
D	186	42	0	2	0	6	15
E	35,382	4,149	145	3,045	41	1,434	3,309
F	17,565	3,024	116	656	20	421	1,393
G	16,032	3,764	161	339	8	593	1,903
Subzone (A-G)Total Population	71,941	11,359	439	4,095	74	2,504	6,809
Wake County Total Population	560,536	182,793	4,503	48,287	387	21,455	87,922

Shadow Evacuation Area

For planning purposes, the area between the 10-mile EPZ border to a 25-mile radius from the plant is known as the Shadow Evacuation Area. The location and extent of the Shadow Evacuation Area is shown in **Figure 5.25**.

FIGURE 5.25: WAKE COUNTY SHADOW EVACUATION AREA

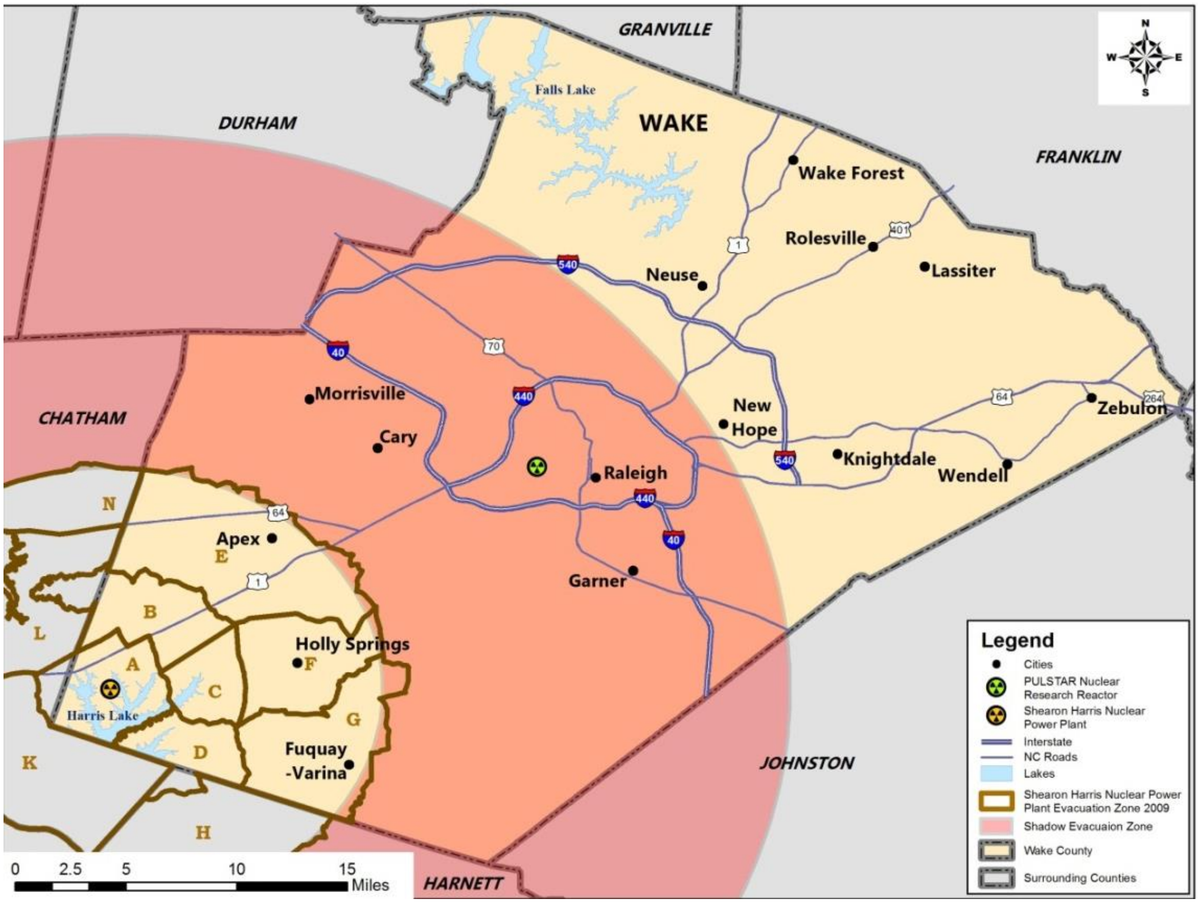


Table 5.65 shows the population between the 10-mile EPZ border to a 25-mile radius from the plant. 65.8 percent of the total population falls within the shadow evacuation area in Wake County. In addition, 44.1 percent of people within this area are in the 18–64 age range, 15.8 percent are under 18, and 5.82 percent are 65 and older.

Table 5.66: SHADOW EVACUATION AREA

Sub-Zone	2010 Population
Population under 18	142,624 (15.8%)
Population 18-64	398,159(44.1%)
Population 65 and over	52,506 (5.82%)
Total Population	593,289 (65.8%)
Wake County Total Population	900,993

Public confidence in the wake of a nuclear accident would be severe and intense given that the hazard is man-made and highly regulated. With past events as an example, reaction to a nuclear event would cause a great loss of in public confidence.

Responders

Responders in a nuclear event would face many issues, not the least of which is exposure to radiation from the nuclear accident. The long-term effects of this exposure are severe and are generally chronic illnesses and death. Additionally, since radiation is not visible to the naked eye, responders may have difficulty recognizing safe zones in a nuclear event.

Continuity of Operations

Given the expected magnitude of the response that would be necessary in the event of a nuclear accident, it is relatively certain that there will be some disruption to operations in the county. Continuity of operations will likely be maintained, but there is at least a moderate risk that some breakdown in normal operations will occur.

Built Environment (Property, Facilities, and Infrastructure)

Wake County critical facilities include fire stations, emergency medical service stations, and hospitals among others. These facilities are critical to overall emergency management and incident stabilization. Direct impacts to these facilities would put stress on the government's ability to respond to a disaster. A number of critical facilities, as well as homes and infrastructure would be impacted by a nuclear event. For a more in depth look at impacts to the built environment, please see *Section 6: Hazard Vulnerability.*

Economy

In the short term, the economy will be impacted by a shutdown of businesses and government operations. However, the long term economic concerns are more devastating as, unlike many natural hazards, the remnants from a nuclear accident (radiation) remain for many years to come. This could potentially reduce the likelihood that new businesses will move to the area in the future and will impact perceptions about current businesses. Moreover, farmland may be unusable and water supply will be affected in many areas.

Environment

The short-term impacts of a radioactive release in Wake County are primarily from direct exposure of humans and animals to dangerous levels of radiation from a radioactive plume and its deposited material. The long-term impacts from a radioactive release include chronic exposure of humans and animals to radiation from radioactive material deposited by a plume, by eating or drinking contaminated food, milk, or water.

5.19 TERROR THREAT

5.19.1 Background

Terrorism is defined in the United States by the Code of Federal Regulations as: "the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives."[37] Academic literature identifies some overarching political goals that terrorism seeks to achieve, including spreading anxiety and alarm among immediate victims, families, and the general public; eliminating opponents and destroying symbolic targets; and generating direct damage on society, such as affecting business confidence. In the following sections, some general background information about terrorism is presented prior to the county's hazard identification and risk assessment findings.

[37] U.S. Code of Federal Regulations. 23 C.F.R. Section 0.85

There are two general types of terrorist groups: network and hierarchical. The type of organization a group adopts largely depends on how long the group has existed. More recently developed groups tend to organize or adapt to the possibilities of the network model. Older, more established groups lean toward the hierarchical structure and are often more associated with violence of a political nature.[38] Terrorist acts can be committed by large, formally organized groups with terrorist cells in different parts of the world, or they can originate from smaller groups or individuals from a small city or domestic "homegrown" location. In the United States, terrorists that are "homegrown" do not belong to a defined group, may operate very effectively "under the radar," and may pose the biggest threat initially at the local level.[39] In 2009, for example, seven longtime residents (now known as the "Tarheel Terrorists") who were suspected of plotting terrorism and for providing money, training, transportation, and men to help terrorists, were arrested in the rural Wake County subdivision of Shadow Oaks.[40] They are currently awaiting trial for terrorist activities documented between 2006 and 2009.[41]

5.19.2 Location and Spatial Extent

A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table 5.66** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

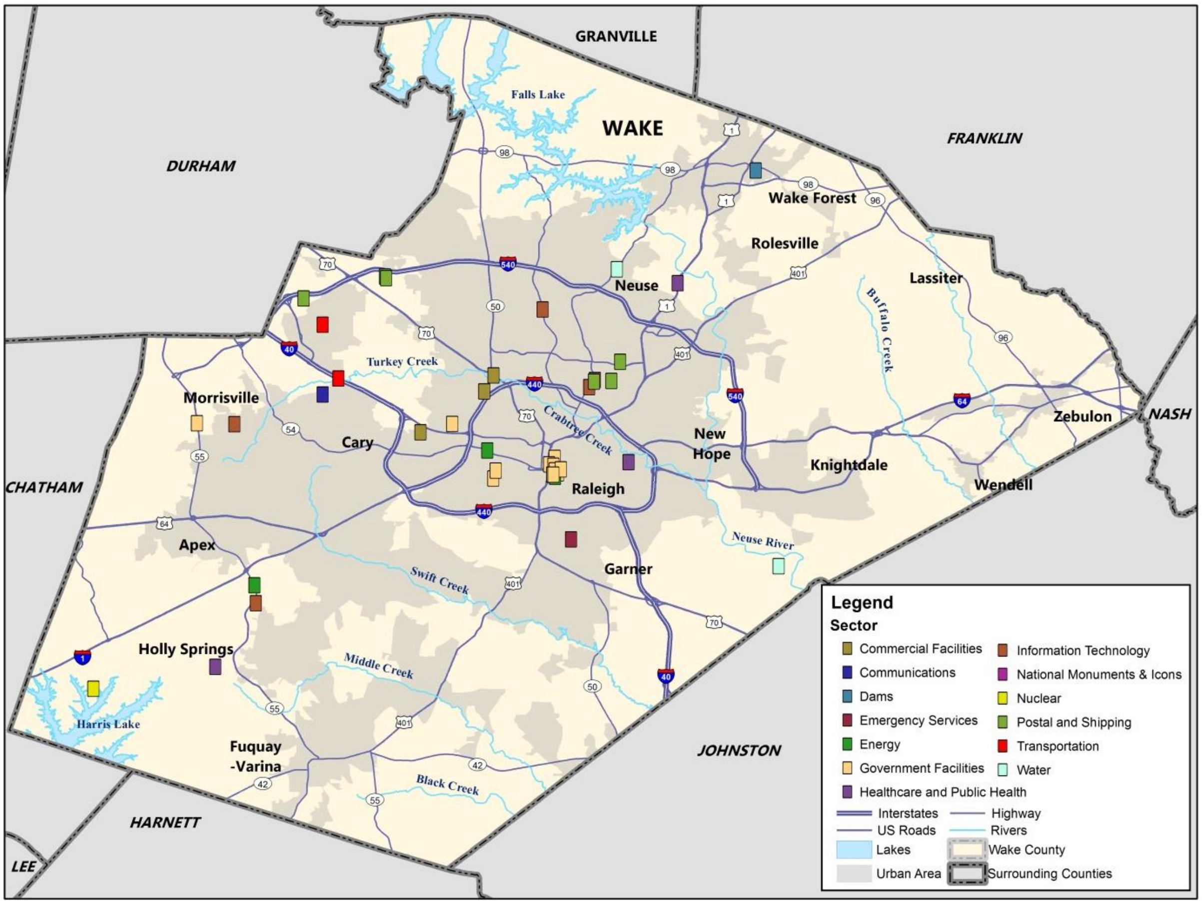
TABLE 5.67 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food	▪ Government Facilities
▪ Banking and Finance	▪ Healthcare and Public Health
▪ Chemical	▪ Information Technology
▪ Commercial Facilities	▪ National Monuments and Icons
▪ Communications	▪ Nuclear Reactors, Materials, and Waste
▪ Critical Manufacturing	▪ Postal and Shipping
▪ Dams	▪ Transportation Systems
▪ Defense Industrial Base	▪ Water
▪ Emergency Services	
▪ Energy	

In Wake County, there are 43 identified critical infrastructure and key resource assets in Wake County, shown in **Figure 5.26**.

[38] Terrorism Research. *Terrorist groups*. Retrieved December 27, 2011, from http://www.terrorism-research.com/groups/
[39] *Ibid*.
[40] WTVD-TV. (2009, July 29). "8th terror suspect wanted." Retrieved May 8, 2012, from http://abclocal.go.com/wtvd/story?section=news/local&id=6935151
[41] Book, S. (2011, Sept. 20). "Jury pool picked for terrorism trial in New Bern." *ENC Today*. Retrieved May 8, 2012, from http://www.enctoday.com/articles/bern-76417-kfpress-jury-court.html

FIGURE 5.26: WAKE COUNTY CRITICAL INFRASTRUCTURE AND KEY RESOURCES (CIKR)



Source: Wake County HIRA Report (2012)

5.19.3 Historical Occurrences

Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

5.19.4 Probability of Future Occurrences

Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

5.19.5 Consequence Analysis

People (The Public and Public Confidence)

A biological or chemical attack may go undetected for hours, days, or potentially weeks until people, animals, or plants show symptoms. The first source of detection for such an attack will likely be by local healthcare workers observing a pattern of unusual illness or by early warning monitoring systems that detect airborne pathogens.

For an aerosol release, an area affected would depend on the quantity of agent release whether the release is indoors or outdoors, and on specific weather conditions. Agents that are released outdoors would disperse in the direction of the wind, while agents released indoors could have a higher concentration overall.

The main effect that a significant food (whether through processing, transport, or distribution) or water contamination (whether through backflow contamination or disabling or sabotaging the drinking water system) could have is the resulting health effects on the general public as well as the public anxiety created from such an attack. The extent of health impacts would depend on the concentration of the chemical or toxin present and the associated effects.

Biological and chemical attacks were identified as potential threats for the North Carolina State Fairgrounds, the North Carolina State Government Complex, and the Wake Medical Center Raleigh Campus. **Table 5.67** shows the estimated effects from the total destruction of these facilities without consideration for the threat, while the percentages show the area that is anticipated to be affected by a biological or a chemical attack given the total destruction values assigned.

Table 5.68: Biological and Chemical Impact Results: People

CIKR	Death and Injury	Public Health and Public Safety	Psychological Influence, Public Confidence and Morale
North Carolina State Government Complex/Capitol building/State Legislative Building	10,000–100,000 (about 60%)	Medium (about 40%)	Significant (about 100%)
North Carolina State Fairgrounds	10,000–100,000 (about 60%)	Medium (about 40%)	Small (about 80%)
Wake Medical Center Raleigh Campus	1,000–10,000 (about 60%)	Significant (about 20%)	Significant (about 60%)

Responders
Responders to a terror threat will face danger themselves as they attempt to control the current threat which is often ongoing in the wake of the first signs of a terrorist act. While attempting to control an event, first responders may also become the targets of terrorist threats and their lives and safety will almost certainly be at risk.

Continuity of Operations
Continuity of operations during a terror threat will be maintained on a large scale, however, on a small scale at the ground level, there will probably be some breakdown of operations as responders attempt to address this event. The rapid onset of an act of terror makes it difficult to react to and often disrupts the normal flow of emergency operations.

Built Environment (Property, Facilities, and Infrastructure)

The area affected by a terrorist incident would depend upon factors such as the type and amount of the biological or chemical agent, means of dispersal, local topography, and local weather conditions. Lethal or life-threatening results could be seen close to where the agent is released where the concentration is the highest, while severe to moderate symptoms could be seen at a distance from the actual event.

Biological and chemical attacks were identified as potential threats for the North Carolina State Fairgrounds, the North Carolina State Government Complex, and the Wake Medical Center Raleigh Campus. **Table 5.68** shows the estimated effects from the total destruction of these facilities—destruction of property and additional CIKR impacts—without consideration for the threat, while the percentages show the area that is anticipated to be affected by a biological or a chemical attack given the total destruction values assigned.

Table 5.69: Biological and Chemical Impact Results: Built Environment

CIKR	Destruction of Property	State/National Government Operations and Security	Additional CIKR Impacts
North Carolina State Government Complex/Capitol Building/State Legislative Building	$1 billion to $100 billion (about 0%)	Medium (about 60%)	Medium (about 40%)
North Carolina State Fairgrounds	$1 million to $100 million (about 0%)	Medium (about 60%)	Medium (about 40%)
Wake Medical Center Raleigh Campus	$100 million to $1 billion (about 0%)	Small (about 0%)	Significant (about 20%)

Economy

There are a series of economic impacts that could result from a terrorist attack on Wake County. Economic impacts could result from deaths, illnesses, loss of jobs, and destruction of workplaces and homes. Cleanup, rebuilding, and replacement of lost property and goods could cost many billions of dollars. In addition, local economic impacts could continue even after the site has been cleaned up if people are concerned about returning to the affected area.

Biological and chemical attacks were identified as potential threats for the North Carolina State Fairgrounds, the North Carolina State Government Complex, and the Wake Medical Center Raleigh Campus. **Table 5.69** shows the estimated economic effects from the total destruction of these facilities without consideration for the threat, while the percentages show the area that is anticipated to be affected by a biological or a chemical attack given the total destruction values given.

Table 5.70: Biological and Chemical Impact Results: Economy

CIKR	Economic Impact
North Carolina State Government Complex/Capitol Building/State Legislative Building	Medium (about 20%)
North Carolina State Fairgrounds	Small (about 20%)

CIKR	Economic Impact
Wake Medical Center Raleigh Campus	Small (about 20%)

Environment

The environmental consequences of a biological or chemical attack within Wake County vary considerably depending on the type of incident and the extent of the incident. In the case of a water- or food-borne attack (e.g., a nerve agent that is readily absorbed through foods but does not change the appearance or taste of the food), agricultural land and livestock as well as drinking water supplies (with the exception of deep groundwater reservoirs and protected water resources, which are safeguarded) could be compromised. Depending on the chemical agent or toxin used, the surrounding physical environment and wildlife could be contaminated or impacted.

In addition, the physical environment could be destroyed or severely damaged by such an attack. If the attack is within the vicinity of wetlands or ecosystems, these areas could also be destroyed or severely compromised. Again, the extent of damage would depend on the concentration of the toxin or the chemical, biological, or radiological agent that is released during the explosion or incident.

Biological and chemical attacks were identified as potential threats for the North Carolina State Fairgrounds, the North Carolina State Government Complex and the Wake Medical Center-Raleigh Campus. **Table 5.70** shows the estimated environmental damage effects from the total destruction of these facilities without consideration for the threat, while the percentages show the area that is anticipated to be affected by a biological or a chemical attack given the total destruction values given.

Table 5.71: Biological and Chemical Impact Results: Environment

CIKR	Environmental damage
North Carolina State Government Complex/Capitol Building/State Legislative Building	Medium (about 0%)
North Carolina State Fairgrounds	Small (about 0%)
Wake Medical Center Raleigh Campus	Medium (about 0%)

5.20 CONCLUSIONS ON HAZARD RISK

The hazard profiles presented in this section were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

5.20.1 Hazard Extent

Table 5.71 describes the extent of each natural hazard identified for Wake County. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE 5.72 EXTENT OF WAKE COUNTY HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page 5:6). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. The county received this ranking (at least three times) over the fourteen year reporting period. Although drought information from the North Carolina Drought Monitor is not specifically reported at the municipal level, it can be assumed that each jurisdiction experienced similar conditions due to its location and the regional impact of the hazard.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Wake County was 4.0 inches. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), the majority of Wake County is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Severe Thunderstorm/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Wake County was reported on September 17, 2004 at 69 knots (approximately 79 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). The greatest magnitude reported was an F4 (last reported on November 28, 1988).
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was around 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals will vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Wake County. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the region was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is between low and moderate. There is also moderate susceptibility in some parts of the county.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). Of the 401 dams in Wake County, 144 are classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records available for Wake County.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 9.2 percent of the total land area in the Wake County. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second. Additional peak discharge readings and gage heights are in the table below.

Location	Date	Peak Discharge (cfs)	Gage Height (ft)
BEAVERDAM CREEK AT DAM NEAR CREEDMOOR, NC	--	--	--
LOWER BARTON CREEK TRIB NR RALEIGH, NC	7/28/1965	355	24.34
FALLS LAKE ABOVE DAM NR FALLS, NC	--	--	--
NEUSE RIVER NEAR FALLS, NC	7/17/1975	13,600	25.21
NEUSE RIVER NEAR NEUSE, NC	9/21/1945	--	26.00
CRABTREE CR AT EBENEZER CHURCH RD NR RALEIGH, NC	9/6/1996	82,007	22.4
CRABTREE CREEK AT HWY 70 AT RALEIGH, NC	6/27/1973	117,007	27.69

	CRABTREE CREEK AT ANDERSON DRIVE AT RALEIGH, NC	--	--	--
	CRABTREE CR AT OLD WAKE FOREST RD AT RALEIGH, NC	--	--	--
	CRABTREE CREEK AT US 1 AT RALEIGH, NC	9/6/1996	12,700	18.23
	PIGEON HOUSE CR AT CAMERON VILLAGE AT RALEIGH, NC	8/21/1999	622	8.23
	MARSH CREEK NEAR NEW HOPE, NC	9/6/1999	3,900	13.33
	ROCKY BRANCH AT DAN ALLEN DRIVE AT RALEIGH, NC	6/18/1967	225	23.8
	ROCKY BRANCH AT CARMICHAEL GYM AT RALEIGH, NC	6/18/1967	485	24.85
	ROCKY BRANCH BELOW PULLEN DRIVE AT RALEIGH, NC	7/24/1997	2,590	9.23
	WALNUT CREEK AT SUNNYBROOK DRIVE NR RALEIGH, NC	9/6/1996	6,760	17.03
	NEUSE R TRIB AT NRWWTP (CMP SITE) NR AUBURN, NC	10/27/2007	276	5.4
	SWIFT CREEK NEAR APEX, NC	5/11/1957	3,105	24.02
	SWIFT CREEK NEAR MCCULLARS CROSSROADS, NC	9/6/1996	67,906	14.15
	UNNAMED TRIB TO SWIFT CR NR YATES MILL POND, NC	8/8/2003	60	2.48
	MIDDLE CREEK NEAR HOLLY SPRINGS, NC	7/28/1965	2,520	26.2
	LITTLE RIVER NEAR ZEBULON, NC	3/29/2009	1,050	2.7
	WHITE OAK CR AT MOUTH NEAR GREEN LEVEL, NC	6/14/2006	5,920	13.5
Other Hazards				
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incident reported in the county is 50 LGA released on the highway in Raleigh. It should be noted that larger events are possible.			

Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).
Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

5.20.2 Priority Risk Index

In order to draw some meaningful planning conclusions on hazard risk for Wake County, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). The purpose of the PRI is to categorize and prioritize all potential hazards for Wake County as high, moderate, or low risk. Combined with the asset inventory and quantitative vulnerability assessment provided in the next section, the summary hazard classifications generated through the use of the PRI allows for the prioritization of those high hazard risks for mitigation planning purposes, and more specifically, the identification of hazard mitigation opportunities for the jurisdictions in Wake County to consider as part of their proposed mitigation strategy.

The prioritization and categorization of identified hazards for Wake County is based principally on the PRI, a tool used to measure the degree of risk for identified hazards in a particular planning area. The PRI is used to assist the Wake County Regional Work Groups in gaining consensus on the determination of those hazards that pose the most significant threat to Wake County and its municipalities based on a variety of factors. The PRI is not scientifically based, but is rather meant to be utilized as an objective planning tool for classifying and prioritizing hazard risks in Wake County based on standardized criteria.

The application of the PRI results in numerical values that allow identified hazards to be ranked against one another (the higher the PRI value, the greater the hazard risk). PRI values are obtained by assigning varying degrees of risk to five categories for each hazard (probability, impact, spatial extent, warning time, and duration). Each degree of risk has been assigned a value (1 to 4) and an agreed upon weighting factor[42], as summarized in **Table 5.72**. To calculate the PRI value for a given hazard, the assigned risk value for each category is multiplied by the weighting factor. The sum of all five categories equals the final PRI value, as demonstrated in the example equation below:

[42] The Regional Work Groups, based upon any unique concerns or factors for the planning area, may adjust the PRI weighting scheme during future plan updates.

PRI VALUE = [(PROBABILITY x .30) + (IMPACT x .30) + (SPATIAL EXTENT x .20) + (WARNING TIME x .10) + (DURATION x .10)]

According to the weighting scheme and point system applied, the highest possible value for any hazard is 4.0. When the scheme is applied for Wake County, the highest PRI value is 3.1 (thunderstorm/high wind hazard). Prior to being finalized, PRI values for each identified hazard were reviewed and accepted by the members of the Regional Work Groups.

TABLE 5.73: PRIORITY RISK INDEX FOR WAKE COUNTY

PRI Category	Degree of Risk			Assigned Weighting Factor
	Level	Criteria	Index Value	
Probability	Unlikely	Less than 1% annual probability	1	30%
	Possible	Between 1 and 10% annual probability	2	
	Likely	Between 10 and 100% annual probability	3	
	Highly Likely	100% annual probability	4	
Impact	Minor	Very few injuries, if any. Only minor property damage and minimal disruption on quality of life. Temporary shutdown of critical facilities.	1	30%
	Limited	Minor injuries only. More than 10% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one day.	2	
	Critical	Multiple deaths/injuries possible. More than 25% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for more than one week.	3	
	Catastrophic	High number of deaths/injuries possible. More than 50% of property in affected area damaged or destroyed. Complete shutdown of critical facilities for 30 days or more.	4	
Spatial Extent	Negligible	Less than 1% of area affected	1	20%
	Small	Between 1 and 10% of area affected	2	
	Moderate	Between 10 and 50% of area affected	3	
	Large	Between 50 and 100% of area affected	4	
Warning Time	More than 24 hours	Self explanatory	1	10%
	12 to 24 hours	Self explanatory	2	
	6 to 12 hours	Self explanatory	3	
	Less than 6 hours	Self explanatory	4	
Duration	Less than 6 hours	Self explanatory	1	10%
	Less than 24 hours	Self explanatory	2	
	Less than one week	Self explanatory	3	
	More than one week	Self explanatory	4	

5.20.3 Priority Risk Index Results

Table 5.73 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE 5.74: SUMMARY OF PRI RESULTS FOR WAKE COUNTY

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	**2.5**
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	**2.4**
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	**2.5**
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	**2.1**
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	**3.1**
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.7**
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	**2.5**
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2.0**
Landslide	Possible	Minor	Small	Less than 6 hours	Less than 6 hours	**1.8**
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	**1.8**
Flood	Likely	Critical	Moderate	6 to 12 hours	Less than 1 week	**3.0**
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	**2.0**
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	**2.6**
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	**2.4**

5.21 FINAL DETERMINATIONS

The conclusions drawn from the hazard profiling process for Wake County, including the PRI results and input from the Regional Work Groups, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table 5.74**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Wake County. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment*. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE 5.75: CONCLUSIONS ON HAZARD RISK FOR WAKE COUNTY

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Nuclear Accident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

SECTION 6
VULNERABILITY ASSESSMENT

This section identifies and quantifies the vulnerability of the jurisdictions within Wake County to the significant hazards identified in the previous sections (*Hazard Identification and Profiles*). It consists of the following subsections:

- 6.1 Overview
- 6.2 Methodology
- 6.3 Explanation of Data Sources
- 6.4 Asset Inventory
- 6.5 Vulnerability Assessment Results
- 6.6 Conclusions on Hazard Vulnerability

44 CFR Requirement
44 CFR Part 201.6(c)(2)(ii): The risk assessment shall include a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. The description shall include an overall summary of each hazard and its impact on the community. The plan should describe vulnerability in terms of: (A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; (B) An estimate of the potential losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate; (C) Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

6.1 OVERVIEW

This section builds upon the information provided in Section 4: *Hazard Identification and* Section 5*: Hazard Profiles* by identifying and characterizing an inventory of assets in Wake County. In addition, the potential impact and expected amount of damages caused to these assets by each identified hazard event is assessed. The primary objective of the vulnerability assessment is to quantify exposure and the potential loss estimates for each hazard. In doing so, Wake County and the participating jurisdictions may better understand their unique risks to identified hazards and be better prepared to evaluate and prioritize specific hazard mitigation actions.

This section begins with an explanation of the methodology applied to complete the vulnerability assessment, followed by a summary description of the asset inventory as compiled for jurisdictions in Wake County. The remainder of this section focuses on the results of the assessment conducted.

6.2 METHODOLOGY

This vulnerability assessment was conducted using three distinct methodologies: (1) A stochastic risk assessment; (2) a geographic information system (GIS)-based analysis; and (3) a risk modeling software analysis. Each approach provides estimates for the potential impact of hazards by using a common, systematic framework for evaluation, including historical occurrence information provided in the *Hazard*

Identification and *Hazard Profiles* sections. A brief description of the three different approaches is provided on the following pages.

6.2.1 Stochastic Risk Assessment

The stochastic risk assessment methodology was applied to analyze hazards of concern that were outside the scope of hazard risk models and the GIS-based risk assessment. This involves the consideration of annualized loss estimates and impacts of current and future buildings and populations. Annualized loss is the estimated long-term weighted average value of losses to property in any single year in a specified geographic area (i.e., municipal jurisdiction or county). This methodology is applied primarily to hazards that do not have geographically-definable boundaries and are therefore excluded from spatial analysis through GIS. A stochastic risk methodology was used for the following hazards:

- Dam Failure
- Drought
- Extreme Heat
- Erosion
- Hailstorm
- Lightning
- Terror Threat
- Thunderstorm Wind/High Wind
- Tornado
- Winter Storm and Freeze

With the exception of Dam Failure, Erosion, and Terror Threat, the hazards listed above are considered atmospheric and have the potential to affect all current and future buildings and all populations. **Table 6.1** provides information about all improved property in Wake County that is vulnerable to these hazards. For all hazards, annualized loss estimates were determined using the best available data on historical losses from sources including NOAA's National Climatic Data Center records, county and municipal hazard mitigation plans, and local knowledge. Annualized loss estimates were generated by totaling the amount of property damage over the period of time for which records were available, and calculating the average annual loss. Given the standard weighting analysis, losses can be readily compared across hazards providing an objective approach for evaluating mitigation alternatives.

For the dam failure[1], erosion, and terror threat, no data with historical property damages was available. Therefore a detailed vulnerability assessment could not be completed for these hazards at this time.

The results for these hazards are found at the end of this section in **Table 6.16**.

[1] As noted in Section 5: *Hazard Profiles*, dam failure could be catastrophic to structures and populations in the inundation area. However, due to lack of data, no additional analysis was performed. Further, local USACE and NCDENR also complete separate dam failure plans to identify risk and response measures.

6.2.2 GIS-Based Analysis

Other hazards have specified geographic boundaries that permit additional analysis using Geographic Information Systems (GIS). These hazards include:

- Flood
- Hazardous Material Incident
- Landslide
- Nuclear Accident
- Wildfire

The objective of the GIS-based analysis was to determine the estimated vulnerability of critical facilities and populations for the identified hazards in Wake County using best available geospatial data. Digital data was collected from local, regional, state, and national sources for hazards and buildings. This included local tax assessor records for individual parcels and buildings and geo-referenced point locations for identified assets (critical facilities and infrastructure, special populations, etc.) when available. ESRI® ArcGIS™ 10.0 was used to assess hazard vulnerability utilizing digital hazard data, as well as local building data. Using these data layers, hazard vulnerability can be quantified by estimating the assessed building value for parcels and/or buildings determined to be located in identified hazard areas. The results of the analysis provided an estimate of the number of parcels, buildings, and critical facilities, as well as the estimated value of those buildings determined to be potentially at risk to the hazards with delineable geographic hazard boundaries.

6.2.3 Risk Modeling Software Analysis

A risk modeling software was used for the following hazards:

- Earthquake
- Hurricane and Tropical Storm

There are several models that exist to model hazards. Hazus-MH was used in this vulnerability assessment to address the aforementioned hazards.

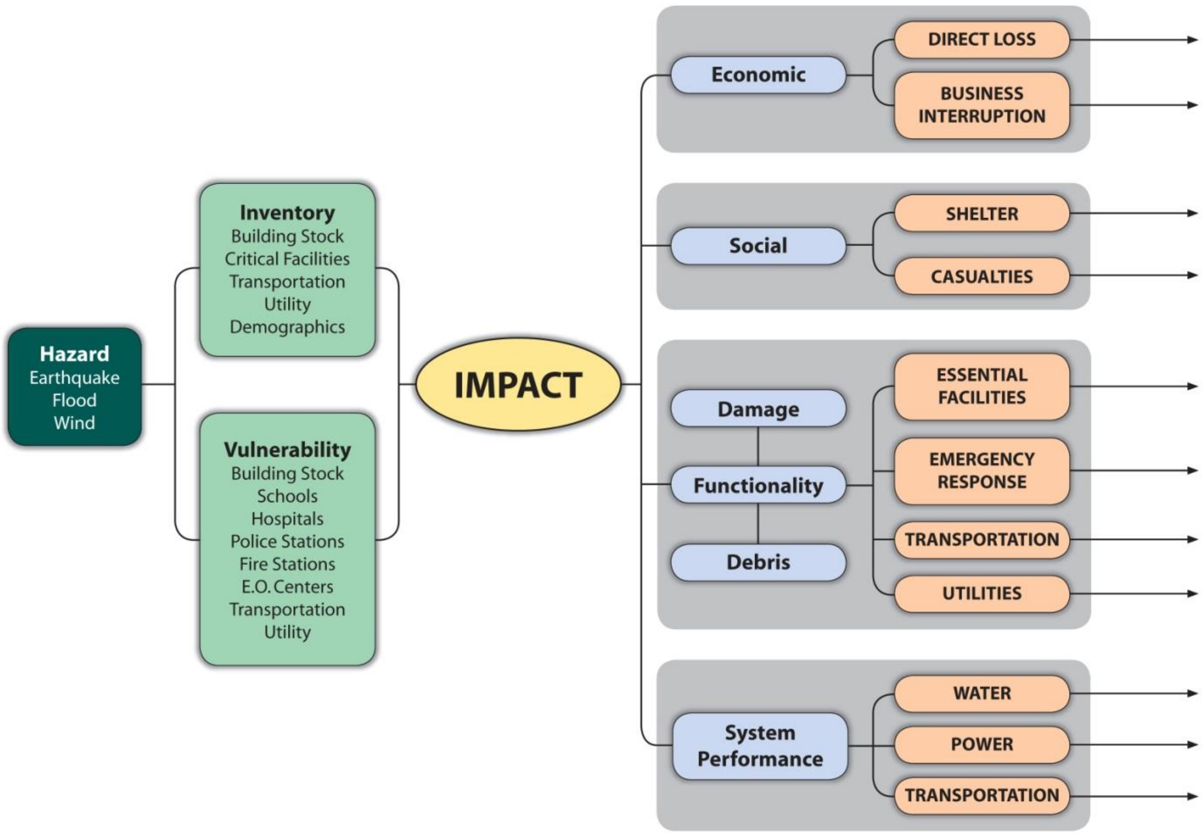
Hazus-MH

Hazus-MH ("Hazus") is a standardized loss estimation software program developed by FEMA. It is built upon an integrated GIS platform to conduct analysis at a regional level (i.e., not on a structure-by-structure basis). The Hazus risk assessment methodology is parametric, in that distinct hazard and inventory parameters (e.g., wind speed and building types) can be modeled using the software to determine the impact (i.e., damages and losses) on the built environment.

The Wake County Risk Assessment utilized Hazus-MH to produce hazard damage loss estimations for hazards for the planning area. At the time this analysis was completed, Hazus-MH 2.1 was used to estimate potential damages from hurricane winds earthquake hazards using Hazus-MH methodology. Although the program can also model losses for flood and storm surge, it was not used in this Risk Assessment.

Figure 6.1 illustrates the conceptual model of the Hazus-MH methodology.

FIGURE 6.1: CONCEPTUAL MODEL OF HAZUS-MH METHODOLOGY



Hazus-MH is capable of providing a variety of loss estimation results. In order to be consistent with other hazard assessments, annualized losses are presented when possible. Some additional results based on location-specific scenarios may also be presented to provide a complete picture of hazard vulnerability.

Loss estimates provided in this vulnerability assessment are based on best available data and methodologies. The results are an approximation of risk. These estimates should be used to understand relative risk from hazards and potential losses. Uncertainties are inherent in any loss estimation methodology, arising in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from approximations and simplifications that are necessary for a comprehensive analysis (e.g., incomplete inventories, non-specific locations, demographics, or economic parameters).

All conclusions are presented in “Conclusions on Hazard Vulnerability” at the end of this section.

6.3 EXPLANATION OF DATA SOURCES

Earthquake

Hazus-MH 2.1 (as described above) was used to assess earthquake vulnerability. A level 1, probabilistic scenario to estimate annualized loss was utilized. In this scenario, several return periods (events of varying intensities) are run to determine annualized loss. Default Hazus earthquake damage functions and methodology were used to determine the probability of damage. Results are calculated at the 2000 U.S. Census tract level in Hazus and presented at the county level.

Flood

FEMA Digital Flood Insurance Rate Maps (DFIRMs) were used to determine flood vulnerability. DFIRM data can be used in ArcGIS for mapping purposes and they identify several features including floodplain boundaries and base flood elevations. Identified areas on the DFIRM represent some features of Flood Insurance Rate Maps including the 100-year flood areas (1.0-percent annual chance flood), and the 500-year flood areas (0.2-percent annual chance flood). For the vulnerability assessment, local parcel data and critical facilities were overlaid on the 100-year floodplain areas and 500-year floodplain areas. It should be noted that such an analysis does not account for building elevation.

Hurricane and Tropical Storm Wind

Hazus-MH 2.1 (as described above) was used to assess wind vulnerability. For the hurricane wind analysis, a probabilistic scenario was created to estimate the annualized loss damage and probable peak wind speeds in Wake County. Default Hazus wind speed data, damage functions, and methodology were used in to determine the probability of damage for 50-, 100-, 500-, and 1,000-year frequency events (also known as return periods) in the scenario. Results are calculated in Hazus at the 2000 U.S. Census tract level and presented at the county and municipal level.

Hazardous Materials Incident

For the fixed hazardous materials incident analysis, Toxic Release Inventory (TRI) data was used. The Toxics Release Inventory is a publicly available database from the federal Environmental Protection Agency (EPA) that contains information on toxic chemical releases and other waste management activities reported annually by certain covered industry groups as well as federal facilities. This inventory was established under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and expanded by the Pollution Prevention Act of 1990. Each year, facilities that meet certain activity thresholds must report their releases and other waste management activities for listed toxic chemicals to EPA and to their state or tribal entity. A facility must report if it meets the following three criteria:

- The facility falls within one of the following industrial categories: manufacturing; metal mining; coal mining; electric generating facilities that combust coal and/or oil; chemical wholesale distributors; petroleum terminals and bulk storage facilities; RCRA Subtitle C treatment, storage, and disposal (TSD) facilities; and solvent recovery services;
- Has 10 or more full-time employee equivalents; and
- Manufactures or processes more than 25,000 pounds or otherwise uses more than 10,000 pounds of any listed chemical during the calendar year. Persistent, bioaccumulative, and toxic (PBT) chemicals are subject to different thresholds of 10 pounds, 100 pounds, or 0.1 grams depending on the chemical.

For the mobile hazardous materials incident analysis, transportation data including major highways and railroads were obtained from the North Carolina Department of Transportation. This data is ArcGIS compatible, lending itself to buffer analysis to determine risk.

Wildfire

The data used to determine vulnerability to wildfire in Wake County is based on GIS data called the Southern Wildfire Risk Assessment (SWRA). It was provided for use in this plan by the North Carolina Division of Forest Resources. A specific layer, known as "Level of Concern" (LOC) was used to determine vulnerability of people and property. The LOC is presented on a scale of 1 to 100. It combines a Wildfire Susceptibility Index (WFSI) with a Fire Effects Index (FEI). The primary purpose of the LOC data is to highlight areas of concern that may be conducive to mitigation actions. Due to the assumptions made, it is not a true probability. However, it does provide a comparison of risk throughout the region.

Nuclear Accident

The data used to determine vulnerability to a nuclear accident in Wake County is based on the location of the Shearon Harris Nuclear Power Station and buffer radii recommended by the Nuclear Regulatory Commission for emergency management planning in the event of a nuclear accident.

6.4 ASSET INVENTORY

An inventory of geo-referenced assets within Wake County and its jurisdictions was compiled in order to identify and characterize those properties potentially at risk to the identified hazards[2]. By understanding the type and number of assets that exist and where they are located in relation to known hazard areas, the relative risk and vulnerability for such assets can be assessed. Under this assessment, two categories of physical assets were created and then further assessed through GIS analysis. These are presented below in Section 6.4.1.

6.4.1 Physical and Improved Assets

The two categories of physical assets consist of:

1. Improved Property: Includes all improved properties in Wake County according to local parcel data provided by the county. The information has been expressed in terms of the number of parcels and total assessed value of improvements (buildings) that may be exposed to the identified hazards. In addition, building footprint data was available for all jurisdictions and it was used to improve the overall assessment by providing an accurate assessment of how many buildings are located in hazard areas. However, it should be noted that building footprint data from all jurisdictions except the City of Raleigh and the Town of Wake Forest has not been updated since 2010, so it likely underestimates building counts. City of Raleigh and Town of Wake Forest data is current through 2013.

2. Critical Facilities: Critical facilities vary by jurisdiction and the critical facilities provided by each jurisdiction are used in this section. It should be noted that this listing is not all-inclusive for assets located in the county, and it is anticipated that it may be expanded or adjusted during future plan updates as more geo-referenced data becomes available for use in GIS analysis.

[2] While potentially not all-inclusive for the jurisdictions in Wake County, "georeferenced" assets include those assets for which specific location data is readily available for connecting the asset to a specific geographic location for purposes of GIS analysis.

The following tables provide a detailed listing of the geo-referenced assets that have been identified for inclusion in the vulnerability assessment Wake County.

Table 6.1 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for participating areas of Wake County (study area of vulnerability assessment).[3]

TABLE 6.1: IMPROVED PROPERTY IN WAKE COUNTY

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Apex	13,428	$4,077,109,333	11,097	$2,987,895,360
Cary	46,916	$19,442,602,988	41,362	$14,004,724,996
Fuquay-Varina	8,830	$2,003,114,842	7,048	$1,500,117,328
Garner	9,882	$2,530,181,294	9,185	$1,799,801,899
Holly Springs	10,253	$2,614,443,181	8,162	$1,967,125,463
Knightdale	4,700	$1,212,124,881	3,704	$885,767,979
Morrisville	5,863	$2,618,506,417	4,377	$1,934,811,737
Raleigh	121,927	$49,135,744,779	165,007	$33,719,903,927
Rolesville	2,224	$541,541,860	1,432	$380,149,908
Wake Forest	12,035	$3,802,436,656	11,476	$2,819,911,530
Wendell	2,576	$398,406,521	2,577	$287,227,420
Zebulon	2,251	$476,102,834	2,145	$346,897,517
Unincorporated Area	92,500	$36,869,910,205	88,745	$20,154,896,961
WAKE COUNTY[4] TOTAL	**333,385**	**$125,722,225,791**	**356,317**	**$82,789,232,025**

Table 6.2 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in Wake County. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. In addition, a list of secondary facilities was created to recognize the importance of these facilities in the event of a disaster. These facilities were not mapped, but it is important to recognize that they could be potentially impacted by nearly any of the identified hazards, especially those that are atmospheric or have no specific spatial delineation.

All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure 6.2** shows the locations of the primary critical facilities in Wake County. **Table 6.17**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect

[3] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

[4] Building value for each jurisdiction is based on the dollar of parcels with an improved building value greater than zero.

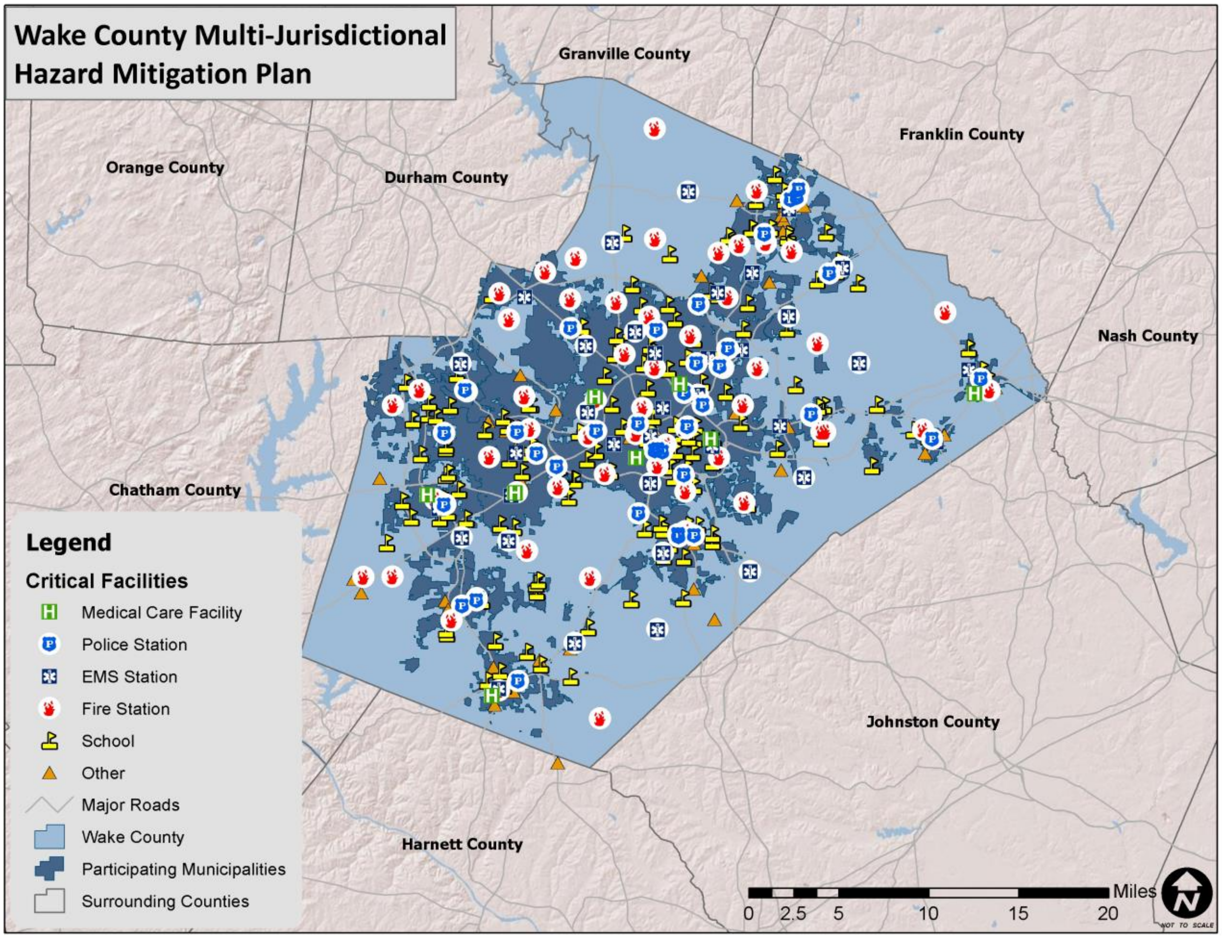
each facility. **Table 6.18** lists all secondary critical facilities. As noted previously, this list is not all-inclusive and only includes information provided by the jurisdictions and certain facilities (police, fire, EMS, medical care, and schools) from Wake County GIS.

TABLE 6.2: CRITICAL FACILITY INVENTORY IN WAKE COUNTY

Location	Fire Stations	Police Stations	EMS Stations	Medical Care Facilities	Schools	Other
Apex	4	1	2	1	10	4
Cary	10	4	4	1	26	5
Fuquay-Varina	1	1	1	1	8	6
Garner	3	5	2	0	9	3
Holly Springs	0	2	0	0	5	3
Knightdale	3	1	1	0	6	2
Morrisville	2	1	1	0	2	1
Raleigh	31	16	15	4	63	4
Rolesville	1	1	1	0	4	1
Wake Forest	4	4	2	0	8	9
Wendell	1	1	1	0	2	6
Zebulon	1	1	0	1	3	2
Unincorporated Area	21	0	11	0	12	4
WAKE COUNTY TOTAL	**82**	**38**	**41**	**8**	**158**	**50**

Source: Local Governments

FIGURE 6.2: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: *Local Governments*

6.4.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Wake County that are potentially at risk to these hazards.

Table 6.3 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, which limited the results to county-wide estimates. The total population in Wake County according to Census data is 900,993 persons. Additional population estimates are presented in Section 3: *Community Profile*.

TABLE 6.3: TOTAL POPULATION IN WAKE COUNTY

Location	Total 2010 Population
Apex	37,476
Cary	135,234
Fuquay-Varina	17,937
Garner	25,745

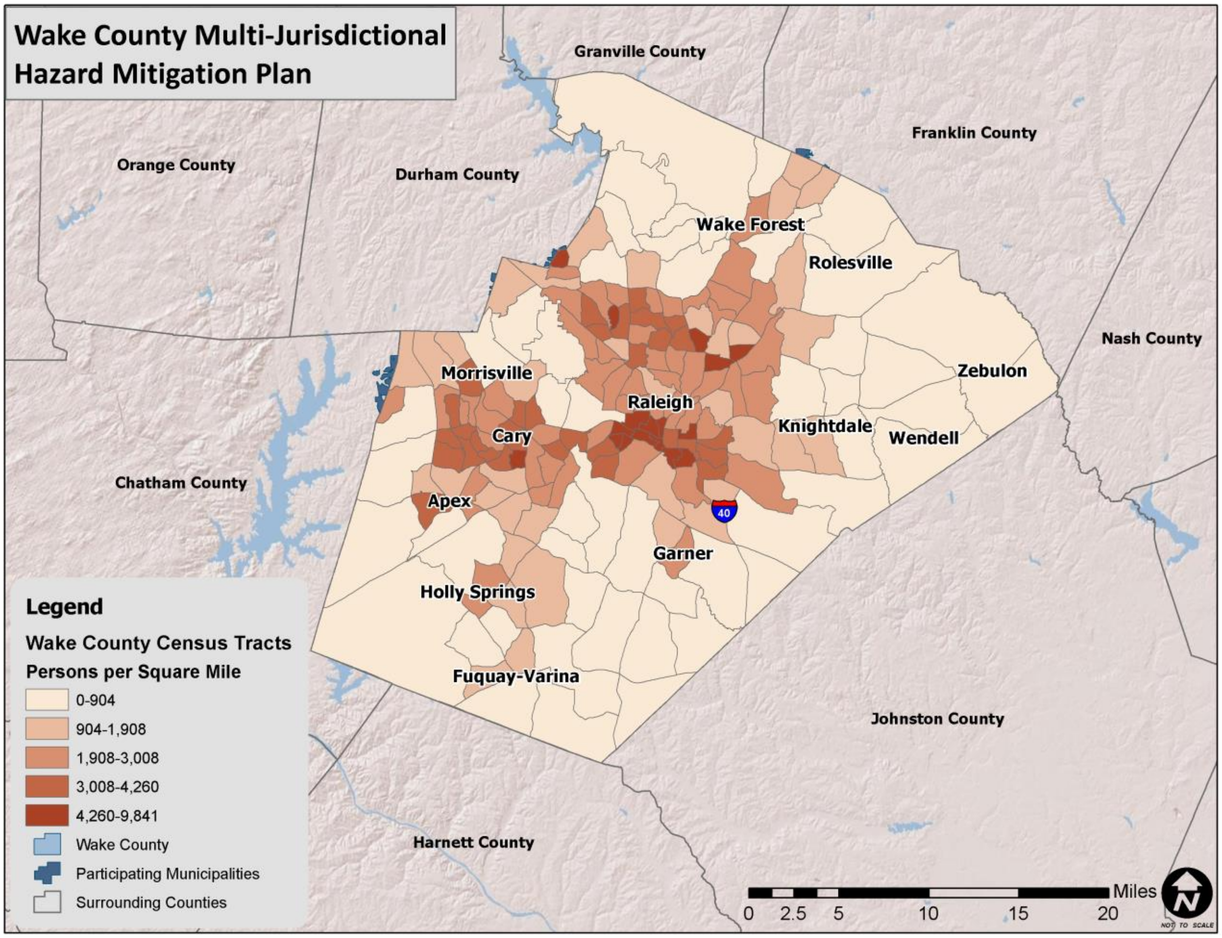
Location	Total 2010 Population
Holly Springs	24,661
Knightdale	11,401
Morrisville	18,576
Raleigh	403,892
Rolesville	3,786
Wake Forest	30,117
Wendell	5,845
Zebulon	4,433
Unincorporated Area	181,890
WAKE COUNTY TOTAL	**900,993**

Note: The total population of Cary, Raleigh, and Wake Forest includes population residing in adjacent counties.
Source: U.S. Census 2010

In addition, **Figure 6.3** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[5]

[5] Population by census block was not available at the time this plan was completed.

FIGURE 6.3: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

6.4.3 Development Trends and Changes in Vulnerability

Since the previous local hazard mitigation plans were approved (between 2009 and 2012), Wake County has experienced some growth and development. **Table 6.4** shows the number of building units constructed since 2010 according to the US Census American Community Survey.

TABLE 6.4: BUILDING COUNTS FOR WAKE COUNTY

Jurisdiction	Total Housing Units (2012)	Units Built 2010 or later	% Building Stock Built Post-2010
Apex	13,410	199	1.5%
Cary	53,824	667	1.2%
Fuquay-Varina	7,380	59	0.8%
Garner	11,416	0	0.0%
Holly Springs	8,698	105	1.2%
Knightdale	4,329	122	2.8%
Morrisville	8,253	273	3.3%
Raleigh	176,564	842	0.5%

Jurisdiction	Total Housing Units (2012)	Units Built 2010 or later	% Building Stock Built Post-2010
Rolesville	1,268	10	0.8%
Wake Forest	11,385	47	0.4%
Wendell	2,984	0	0.0%
Zebulon	1,830	22	1.2%
Unincorporated Area	70,322	138	0.2%
WAKE COUNTY TOTAL	**371,663**	**2,484**	**0.7%**

Source: US Census Bureau

Table 6.5 shows population growth estimates for the county and municipalities from 2010 to 2013 based on the US Census Annual Estimates of Resident Population.

TABLE 6.5: POPULATION GROWTH FOR WAKE COUNTY

Jurisdiction	Population Estimates (as of July 1)				% Change 2010-2013
	2010	2011	2012	2013	
Apex	37,770	38,787	40,460	42,214	11.8%
Cary	136,543	141,787	145,794	151,088	10.7%
Fuquay-Varina	18,189	19,141	19,970	21,277	17.0%
Garner	25,887	26,348	26,749	26,772	3.4%
Holly Springs	24,902	25,775	26,871	28,915	16.1%
Knightdale	11,529	12,055	12,736	13,291	15.3%
Morrisville	18,803	19,548	20,603	21,932	16.6%
Raleigh	406,324	414,094	423,338	431,746	6.3%
Rolesville	3,817	4,039	4,253	4,649	21.8%
Wake Forest	30,351	31,667	32,997	34,752	14.5%
Wendell	5,886	6,085	6,159	6,135	4.2%
Zebulon	4,453	4,533	4,604	4,591	3.1%
Unincorporated Area	182,490	185,211	187,609	186,927	2.4%
WAKE COUNTY TOTAL	**906,944**	**929,070**	**952,143**	**974,289**	**7.4%**

Note: July 1 population estimates were used in this table to allow comparison of annual population counts (April 1 Census estimates were used for all other population counts throughout the plan which is why the counts may differ).
Source: US Census Bureau

Based on the data above, there has been a relatively low rate of residential development in the county since 2010. However, Knightdale and Morrisville have experienced slightly higher rates of development compared to the rest of the county, resulting in an increased number of structures that are vulnerable to the potential impacts of the identified hazards. Additionally, there have been higher rates of population growth in the following municipalities: Apex, Cary, Fuquay-Varina, Holly Springs, Knightdale, Morrisville, Rolesville, and Wake Forest. Since the population has increased in these municipalities, there are now greater numbers of people exposed to the identified hazards. Therefore, development and population growth have impacted the county's vulnerability since the previous local hazard mitigation plans were approved and there has been a slight increase in the overall vulnerability.

It is also important to note that as development increases in the future, greater populations and more structures and infrastructure will be exposed to potential hazards if development occurs in the floodplains, moderate landside susceptibility areas, high wildfire risk areas, primary and secondary TRI site buffers, or Shearon Harris Nuclear Station's 10-mile buffer.

6.5 VULNERABILITY ASSESSMENT RESULTS

As noted earlier, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total region exposure, and thus risk, was presented in **Table 6.1**.

The annualized loss estimate for all hazards is presented at the end of this section in **Table 6.16.**

The hazards presented in this subsection include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

6.5.1 Hurricane and Tropical Storm

Historical evidence indicates that Wake County has a significant risk to the hurricane and tropical storm hazard. There have been three disaster declarations due to hurricanes (Hurricane Fran, Hurricane Floyd, and Hurricane Isabel) in the county. Several tracks have come near or traversed through Wake County, as shown and discussed in Section 5: *Hazard Profiles*.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes and high winds, and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the region as shown below in **Table 6.6.** In the comparative annualized loss analysis at the end of this section, only losses to buildings are reported in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE 6.6: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table 6.7.**

TABLE 6.7: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Apex	74.2	83.4	102.3	109.0

Location	50-year event	100-year event	500-year event	1,000-year event
Cary	74.2	83.4	102.3	109.0
Fuquay-Varina	75.9	85.0	104.6	111.1
Garner	76.2	85.6	104.6	111.2
Holly Springs	74.2	83.4	102.3	109.0
Knightdale	75.8	84.9	103.0	109.4
Morrisville	72.4	81.4	100.0	106.5
Raleigh	75.8	85.1	103.1	109.8
Rolesville	73.8	82.9	100.6	107.0
Wake Forest	73.8	82.9	100.6	107.1
Wendell	76.6	85.6	103.0	110.3
Zebulon	76.3	85.7	103.0	108.9
MAXIMUM WIND SPEED REPORTED	**76.6**	**85.7**	**104.6**	**111.2**

Source: Hazus-MH 2.1

Social Vulnerability

Given some equal susceptibility across Wake County, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Wake County, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table 6.17** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Wake County. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

6.5.2 Earthquake

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table 6.8** summarizes the findings.

TABLE 6.8: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability

It can be assumed that all existing and future populations are at risk to the earthquake hazard.

Critical Facilities

The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table 6.17**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Wake County. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

6.5.3 Landslide

In order to complete the vulnerability assessment for landslides in Wake County, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section 5: *Hazard Profiles*), county level tax parcel and building footprint data, and GIS analysis. **Table 6.9** presents the potential at-risk property where available. Most of the county is located outside of high and moderate risk areas as determined by the USGS landslide data. However, there are some areas that are considered to be of moderate risk in the western part of the county. Typically, an analysis is run to determine which parcels/buildings are located within the high and moderate incidence areas, but since no high incidence areas exist, only an analysis of moderate incidence areas was carried out.

TABLE 6.9: TOTAL POTENTIAL AT-RISK PARCELS/BUILDINGS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	Moderate		
Apex	12,673	10,548	$2,866,496,753
Cary	30,128	24,023	$8,633,636,293
Fuquay-Varina	0	0	$0
Garner	0	0	$0
Holly Springs	742	95	$114,857,151
Knightdale	0	0	$0
Morrisville	5,863	4,377	$1,934,811,737
Raleigh	4,995	6,645	$1,998,001,868
Rolesville	0	0	$0
Wake Forest	0	0	$0
Wendell	0	0	$0

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	**Moderate**		
Zebulon	0	0	$0
Unincorporated Area	6,673	5,396	$3,145,211,453
WAKE COUNTY TOTAL	**61,074**	**51,084**	**$18,693,015,255**

Source: USGS

Social Vulnerability

Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides.

Critical Facilities

Several critical facilities are located in a moderate susceptibility area. In unincorporated Wake County, there are 1 EMS station, 4 fire stations, and one assisted living facility in the area of moderate susceptibility (moderate incidence). In Apex, all critical facilities are located in this area, including 2 EMS stations, 5 fire stations, 1 medical care facility, 1 police station, 10 schools, and 4 others. In Cary, there are 1 EMS station, 3 fire stations, 1 police station, 11 schools, and 4 others. All of Morrisville's critical facilities are located in moderate zone, including 1 EMS station, 2 fire stations, 1 police station, 2 schools, and 1 other. One school and one fire station in Raleigh are located in the moderate susceptibility area (moderate incidence). The remaining critical facilities are located in the low landslide susceptibility area. A list of specific critical facilities and their associated risk can be found in **Table 6.17** at the end of this section.

In conclusion, a landslide has the potential to impact some existing and future buildings, facilities, and populations in Wake County, though most areas are at a very low risk. Due to a variety of factors such as steep slopes and modified slopes, hilly areas of the county bear a greater risk than flat areas. Specific vulnerabilities for Wake County assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

6.5.4 Flood

Historical evidence indicates that Wake County is susceptible to flood events. A total of 100 flood events have been reported by the National Climatic Data Center resulting in $10.6 million dollars in damages.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for each of the Wake County municipalities. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. Wake County is also notably one of the few counties in the state that has mapped future conditions of the 1.0 percent annual chance floodplain. Although this risk area often overlaps with the 0.2 percent annual chance flood area, it is still included in this analysis, albeit in a separate table. **Table 6.10** and **Table 6.11** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE 6.10: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO THE FLOOD HAZARD

Location	1.0-percent ACF			0.2-percent ACF		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[6]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[7]
Apex	258	66	$76,530,969	9	5	$2,280,162
Cary	1,377	536	$889,772,939	220	126	$114,270,309
Fuquay-Varina	217	25	$42,721,538	44	20	$7,408,483
Garner	485	113	$91,838,660	53	59	$14,149,371
Holly Springs	187	23	$62,514,913	51	18	$13,645,602
Knightdale	129	21	$47,608,720	41	20	$10,195,398
Morrisville	165	51	$179,283,154	67	97	$65,773,450
Raleigh	4,290	2,080	$3,539,297,338	1,018	924	$329,892,256
Rolesville	2	0	$0	0	0	$0
Wake Forest	789	201	$370,427,376	122	81	$31,659,382
Wendell	80	2	$21,156,386	15	12	$1,039,584
Zebulon	59	21	$38,958,547	6	0	$2,141,294
Unincorporated Area	6,093	373	$2,834,713,327	467	192	$237,670,063
WAKE COUNTY TOTAL	**14,131**	**7,796**	**$8,194,823,867**	**2,113**	**1,554**	**$830,125,354**

Source: FEMA DFIRM

TABLE 6.11: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO THE FLOOD HAZARD

Location	1.0-percent ACF Future Conditions		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[8]
Apex	214	45	$76,999,816
Cary	570	186	$304,368,117
Fuquay-Varina	7	0	$2,546
Garner	25	6	$1,713,476
Holly Springs	4	1	$1,234,937
Knightdale	6	0	$605,636
Morrisville	6	0	$17,329,015

[6] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 1.0-percent annual chance floodplain, since building footprints were not associated with dollar value data.
[7] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 0.2-percent annual chance floodplain, since building footprints were not associated with dollar value data.
[8] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the Future Conditions 1.0-percent annual chance floodplain, since building footprints were not associated with dollar value data.

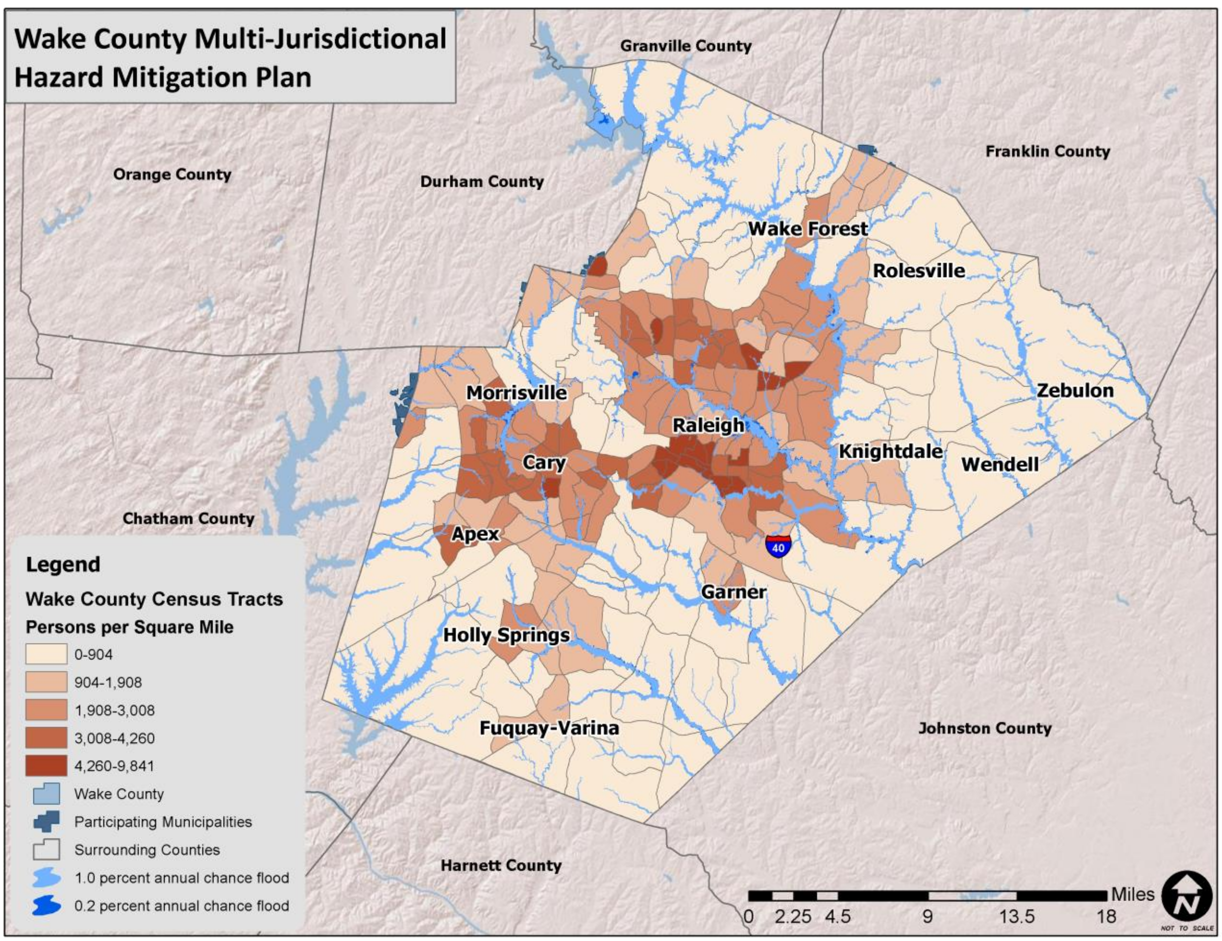
Location	1.0-percent ACF Future Conditions		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[8]
Raleigh	1,131	335	$836,014,532
Rolesville	0	0	$0
Wake Forest	25	1	$27,883,823
Wendell	0	0	$0
Zebulon	43	19	$36,697,607
Unincorporated Area	1,992	100	$1,278,809,978
WAKE COUNTY TOTAL	**4,023**	**693**	**$2,581,659,483**

Source: FEMA DFIRM

Social Vulnerability

U.S. Census 2010 population at the tract level was used for analysis to determine where areas of high population concentration intersect with flood prone areas in the county. **Figure 6.4** is presented to gain a better understanding of at risk population.

FIGURE 6.4 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities

The critical facility analysis revealed that there is only one critical facility located in either the 1.0-percent annual chance floodplain or the 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. (As previously noted, this analysis does not consider building elevation, which may negate risk.) This facility is the Keeter Training Center for Firefighters in Raleigh and it is located at least partially in the 1.0 percent annual chance floodplain. A list of specific critical facilities and their associated risk can be found in **Table 6.17** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings, facilities, and populations in Wake County, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

6.5.5 Hazardous Materials Incident

Although historical evidence and existing Toxic Release Inventory sites indicate that Wake County is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Wake County.

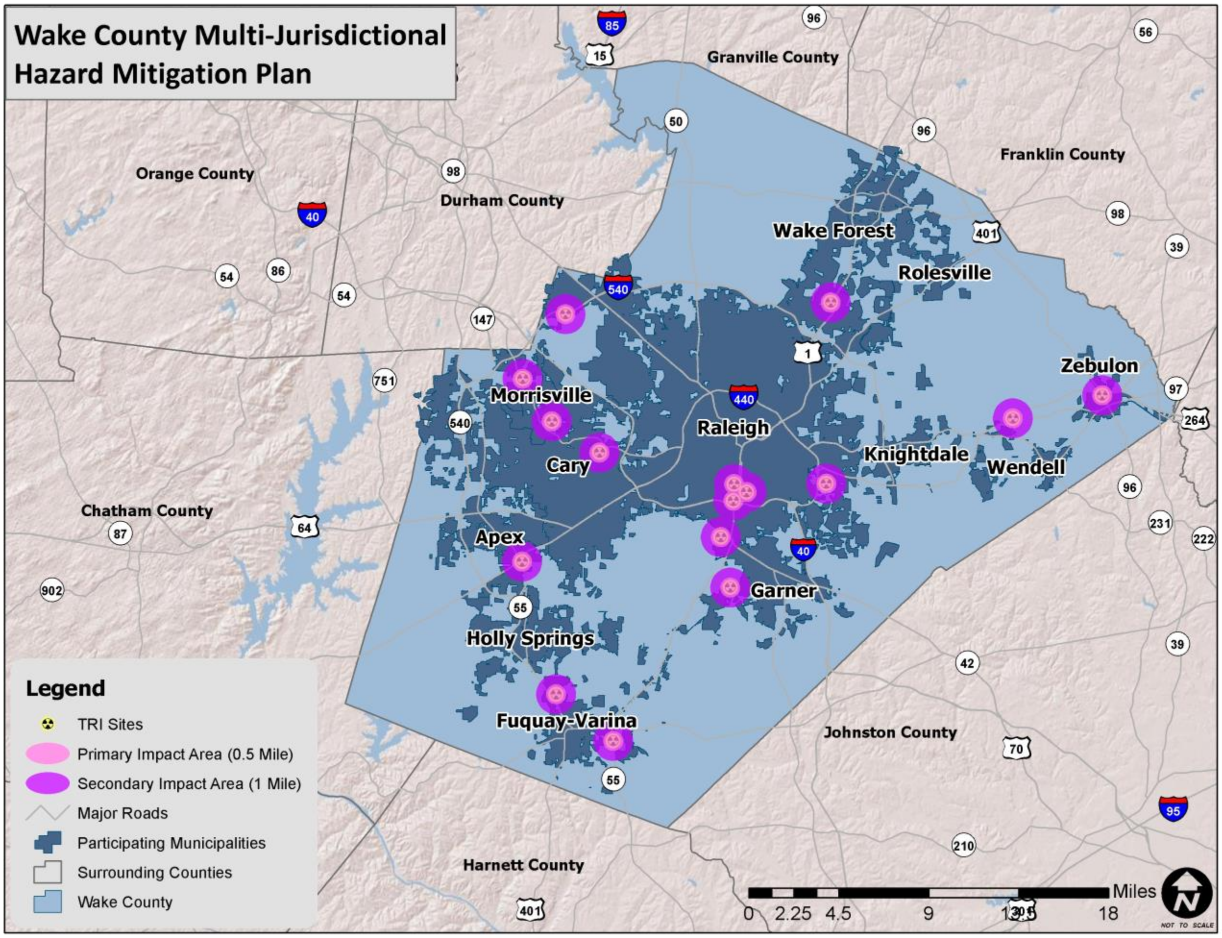
Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[9] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Wake County, along with buffers, were used for analysis as shown in **Figure 6.5.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the

[9] This type of analysis will likely yield inflated results (generally higher than what is actually reported after an actual event).

GIS buffer analysis. **Figure 6.6** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels/buildings and improved value, as shown in **Table 6.12** (fixed sites), **Table 6.13** (mobile road sites) and **Table 6.14** (mobile railroad sites).[10]

FIGURE 6.5 : TRI SITES WITH BUFFERS IN WAKE COUNTY



Source: EPA

TABLE 6.12: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value[11]	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value[12]
Apex	51	121	$69,775,580	695	706	$234,545,987
Cary	955	1,256	$286,638,537	4,017	4,547	$1,052,794,000
Fuquay-Varina	562	476	$85,625,260	2,574	1,719	$428,181,023
Garner	99	77	$50,611,119	901	808	$206,577,359

[10] Note that parcels included in the 1mile analysis are also included in the 0.5-mile analysis.
[11] Improved value is estimated based on the building value associated with parcels that have been identified as being located in the 0.5-mile buffer, since building footprints were not associated with dollar value data.
[12] Improved value is estimated based on the building value associated with parcels that have been identified as being located in the 1.0-mile buffer, since building footprints were not associated with dollar value data.

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value[11]	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value[12]
Holly Springs	0	0	$0	0	0	$0
Knightdale	0	0	$0	0	0	$0
Morrisville	420	374	$229,928,761	1,596	1,243	$778,958,787
Raleigh	2,649	2,765	$955,126,130	9,522	9,576	$3,971,361,436
Rolesville	0	0	$0	0	0	$0
Wake Forest	0	0	$0	4	11	$1,078,101
Wendell	19	18	$4,749,408	96	111	$30,683,271
Zebulon	409	432	$89,772,024	1,459	1,449	$244,329,129
Unincorporated Area	750	452	$884,583,035	3,345	2,599	$1,474,039,219
WAKE COUNTY TOTAL	**5,914**	**5,971**	**$2,656,809,854**	**24,209**	**22,769**	**$8,422,548,312**

FIGURE 6.6 : MOBILE HAZMAT BUFFERS IN WAKE COUNTY

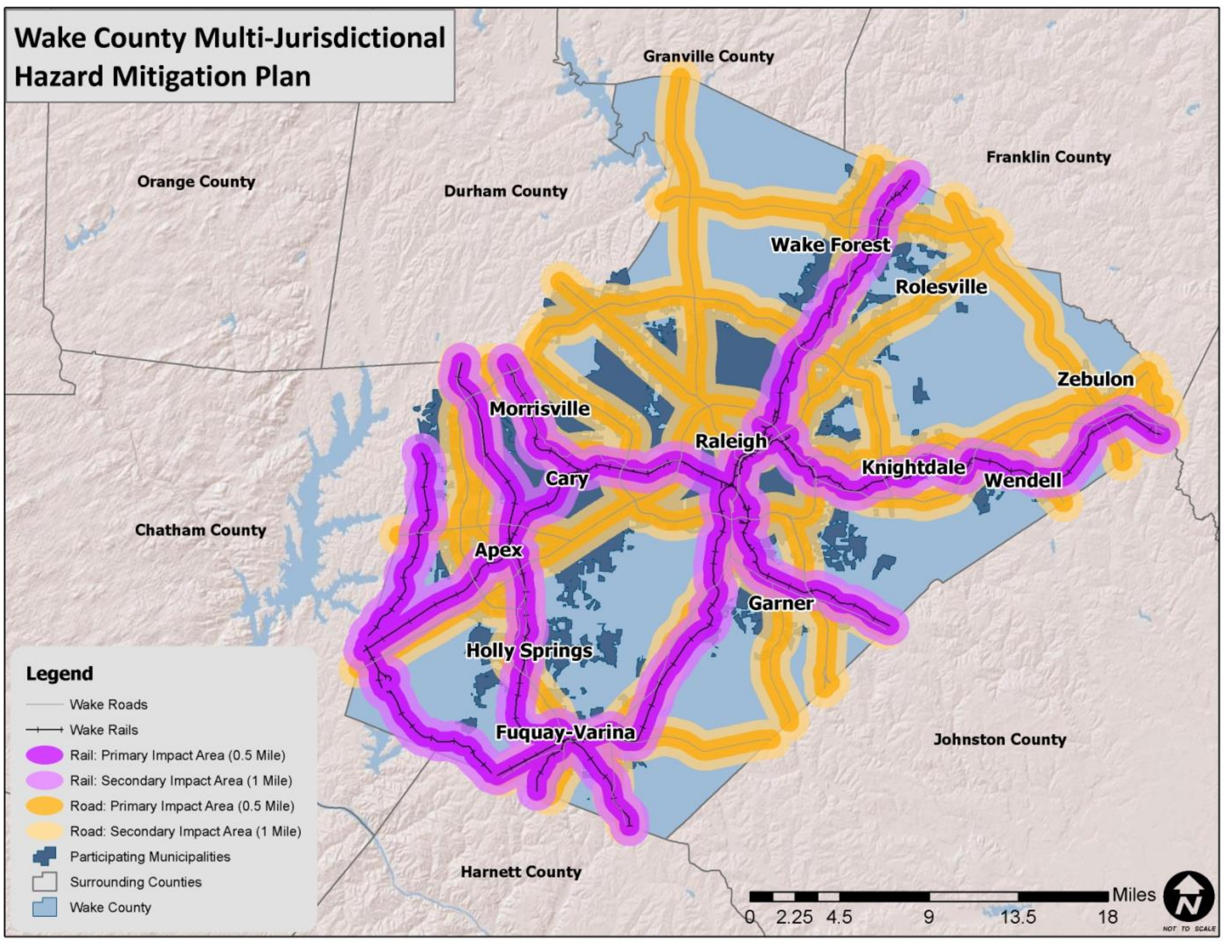


TABLE 6.13: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value[13]	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value[14]
Apex	8,594	7,334	$2,097,748,678	13,001	10,839	$2,918,031,327
Cary	12,009	10,601	$4,743,131,291	26,072	22,519	$8,772,490,046
Fuquay-Varina	6,025	4,876	$1,008,518,985	7,913	6,380	$1,342,413,178
Garner	4,269	3,895	$925,335,883	7,473	6,772	$1,423,945,580
Holly Springs	3,871	3,410	$606,310,663	5,429	4,562	$874,552,521
Knightdale	3,042	2,393	$656,532,998	4,588	3,630	$867,672,937
Morrisville	3,316	2,335	$1,140,036,324	5,497	4,089	$1,794,514,730
Raleigh	51,224	66,676	$18,326,797,532	91,952	121,100	$27,821,957,624
Rolesville	1,178	879	$215,548,841	1,927	1,416	$347,126,021
Wake Forest	6,844	6,987	$1,445,105,064	9,208	9,345	$2,003,231,609
Wendell	2,056	2,132	$250,377,132	2,525	2,571	$286,405,852
Zebulon	2,172	2,114	$343,376,813	2,251	2,145	$346,897,517
Unincorporated Area	29,836	26,417	$8,095,982,143	51,171	47,032	$12,306,306,740
WAKE COUNTY TOTAL	134,436	140,049	$39,854,802,347	229,007	242,400	$61,105,545,682

TABLE 6.14: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value[15]	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value[16]
Apex	4,970	3,739	$971,882,327	8,489	6,589	$1,801,300,511
Cary	12,115	11,396	$2,910,061,363	26,174	23,339	$6,618,704,404
Fuquay-Varina	4,368	3,675	$804,969,402	7,279	5,941	$1,226,584,243
Garner	2,369	2,286	$559,538,532	5,107	4,843	$1,047,259,512
Holly Springs	3,549	3,093	$549,178,328	5,194	4,416	$836,700,987
Knightdale	3,183	2,371	$454,248,736	3,997	3,094	$742,764,190
Morrisville	3,005	2,260	$1,041,309,811	5,376	3,981	$1,673,268,282
Raleigh	18,660	25,563	$8,902,424,404	38,922	53,598	$13,836,287,651
Rolesville	0	0	$0	0	0	$0
Wake Forest	3,975	4,525	$803,998,355	6,645	6,942	$1,448,927,511

[13] Improved value is estimated based on the building value associated with parcels that have been identified as being located in the 0.5-mile buffer, since building footprints were not associated with dollar value data.
[14] Improved value is estimated based on the building value associated with parcels that have been identified as being located in the 1.0-mile buffer, since building footprints were not associated with dollar value data.
[15] Improved value is estimated based on the building value associated with parcels that have been identified as being located in the 0.5-mile buffer, since building footprints were not associated with dollar value data.
[16] Improved value is estimated based on the building value associated with parcels that have been identified as being located in the 1.0-mile buffer, since building footprints were not associated with dollar value data.

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value[15]	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value[16]
Wendell	1,585	1,639	$175,138,028	2,349	2,343	$255,120,766
Zebulon	826	886	$152,232,553	1,680	1,805	$263,618,682
Unincorporated Area	11,758	10,547	$2,979,477,839	21,718	20,060	$5,352,080,287
WAKE COUNTY TOTAL	**70,363**	**71,980**	**$20,304,459,678**	**132,930**	**136,951**	**$35,102,617,026**

Social Vulnerability

Given high susceptibility across Wake County, it is assumed that the total population is at risk to hazardous materials incidents. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities

Fixed Site Analysis:

The critical facility analysis for fixed TRI sites revealed that there are 44 facilities located in a HAZMAT risk zone. The primary impact zone includes thirteen facilities, 1 EMS station, 3 fire stations, 3 police stations, 4 schools and 2 others. The remaining facilities are in the secondary, 1.0-mile zone. This includes 6 EMS stations, 11 fire stations, 2 medical care facilities, 6 police stations, 15 schools, and 4 others. A list of specific critical facilities and their associated risk can be found in **Table 6.17** at the end of this section.

Mobile Analysis:

The critical facility analysis for road and railroad transportation corridors revealed that there are 297 critical facilities located in the primary and secondary mobile HAZMAT buffer areas for roads and 79 critical facilities located in the railroad HAZMAT buffer areas. The 1.0-mile road buffer area (worst case scenario modeled) includes the following critical facilities: 33 EMS stations, 58 fire stations, 8 medical care facilities, 34 police stations, 118 schools, and 46 others. The railroad buffer areas include 201 facilities as follows: 24 EMS stations, 35 fire stations, 5 medical care facilities, 27 police stations, 73 schools, and 37 others. It should be noted that many of the facilities located in the buffer areas for railroad are also located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table 6.17** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Wake County. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc.

6.5.6 Wildfire

Although historical evidence indicates that Wake County has some risk to wildfire events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the region.

To estimate exposure to wildfire, the approximate number of parcels and their associated improved value was determined using GIS analysis. For the critical facility analysis, areas of concern were intersected with critical facility locations. The data used to analyze wildfire risk is called Level of Concern (LOC). Initially provided as raster data, it was converted to a polygon to allow for analysis. The LOC data ranges from 1 – 100 with higher values being most severe (as noted previously, this is only a measure of relative risk). Two was the highest level recorded in the Wake County planning area which indicates that relative risk is very low for the county and its incorporated municipalities. For the analysis, areas with a value above 1 were chosen to be displayed as areas of risk. However, even with this low standard for classifying an area as susceptible, the region contains very little land area where the value falls into the at-risk category. Since all of this land area is on the lower fiftieth of the overall LOC scale, there is likely considerably less risk in the region than in other areas of the country.

Upon conversion of the data and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the county should be assumed to be very low.

Social Vulnerability
All areas have relatively equal vulnerability and there is low susceptibility across the entire county. It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities
The critical facility analysis revealed that there are no critical facilities located in the level of concern area for wildfire in Wake County. A list of specific critical facilities and their associated risk can be found in **Table 6.17** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Wake County.

6.5.7 Nuclear Accident

The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table 6.15** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE 6.15: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[17]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[18]
Apex	12,107	9,794	$2,617,633,591	13,428	11,097	$2,987,895,360
Cary	782	766	$285,094,552	46,916	41,362	$14,004,724,996
Fuquay-Varina	5,706	4,613	$872,156,725	8,830	7,048	$1,500,117,328
Garner	0	0	$0	9,882	9,185	$1,799,801,899
Holly Springs	10,014	7,960	$1,895,491,015	10,253	8,162	$1,967,125,463
Knightdale	0	0	$0	4,700	3,704	$885,767,979
Morrisville	0	0	$0	5,863	4,377	$1,934,811,737
Raleigh	0	0	$0	121,927	165,007	$33,719,903,927
Rolesville	0	0	$0	2,224	1,432	$380,149,908
Wake Forest	0	0	$0	12,035	11,476	$2,819,911,530
Wendell	0	0	$0	2,576	2,577	$287,227,420
Zebulon	0	0	$0	2,251	2,145	$346,897,517
Unincorporated Area	10,274	8,993	$2,050,839,254	92,500	88,745	$20,154,896,961
WAKE COUNTY TOTAL	**38,883**	**32,126**	**$7,721,215,137**	**333,385**	**356,317**	**$82,789,232,025**

Source: International Atomic Energy Agency

Social Vulnerability

Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities

The critical facility analysis revealed that there are a total of forty-four critical facilities located in the 10-mile nuclear buffer area. This includes the following: 1 EMS station, 4 fire stations, and 1 other facility in unincorporated Wake County; 2 EMS stations, 3 fire stations, 1 police station, 1 medical care facility, 7 schools, and 4 others in Apex; 1 other facility in Cary; 1 EMS station, 1 fire station, 1 medical care facility, 4 schools, and 1 other facility in Fuquay-Varina; 2 police stations, 5 schools, and 3 others in Holly Springs. All critical facilities in all jurisdictions are located within the 50-mile nuclear buffer. A list of specific critical facilities and their associated risk can be found in **Table 6.17** at the end of this section.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in the Wake County, though areas in the southwest of the county are at a higher risk than others. All structures in the county are at some risk given that they are all located within the 50-mile buffer area.

[17] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.
[18] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

6.6 CONCLUSIONS ON HAZARD VULNERABILITY

The results of this vulnerability assessment are useful in at least three ways:

- Improving our understanding of the risk associated with the natural hazards in Wake County through better understanding of the complexities and dynamics of risk, how levels of risk can be measured and compared, and the myriad of factors that influence risk. An understanding of these relationships is critical in making balanced and informed decisions on managing the risk.
- Providing a baseline for policy development and comparison of mitigation alternatives. The data used for this analysis presents a current picture of risk in Wake County. Updating this risk "snapshot" with future data will enable comparison of the changes in risk with time. Baselines of this type can support the objective analysis of policy and program options for risk reduction in the region.
- Comparing the risk among the natural hazards addressed. The ability to quantify the risk to all these hazards relative to one another helps in a balanced, multi-hazard approach to risk management at each level of governing authority. This ranking provides a systematic framework to compare and prioritize the very disparate natural hazards that are present in Wake County. This final step in the risk assessment provides the necessary information for local officials to craft a mitigation strategy to focus resources on only those hazards that pose the most threat to Wake County and its municipalities.

Exposure to hazards can be an indicator of vulnerability. Economic exposure can be identified through locally assessed values for improvements (buildings), and social exposure can be identified by estimating the population exposed to each hazard. This information is especially important for decision-makers to use in planning for evacuation or other public safety related needs.

The types of assets included in these analyses include all building types in the participating jurisdictions. Specific information about the types of assets that are vulnerable to the identified hazards is included in each hazard subsection (for example all building types are considered at risk to the winter storm hazard and commercial, residential, and government owned facilities are at risk to repetitive flooding, etc).

Table 6.16 presents a summary of annualized loss for each hazard in Wake County. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, an annualized loss was determined through the damage reported through historical occurrences at the county level. These values should be used as an additional planning tool or measure risk for determining hazard mitigation strategies throughout the region.

TABLE 6.16: ANNUALIZED LOSS FOR WAKE COUNTY*

Event	Apex	Cary	Fuquay-Varina	Garner	Holly Springs	Knightdale	Morrisville
Dam Failure	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Drought	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Erosion	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Extreme Heat	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

Event	Apex	Cary	Fuquay-Varina	Garner	Holly Springs	Knightdale	Morrisville
Hail	Negligible	$450	Negligible	Negligible	Negligible	Negligible	Negligible
Hurricane & Tropical Storm**	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Landslide	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Lightning	$4,785	$8,879	Negligible	Negligible	$487,721	$1,407	$5,305
Thunderstorm Wind/High Wind[19]	$2,567	$2,560	$25,950	Negligible	$6,269	$375	Negligible
Tornado	Negligible	$4,875	Negligible	$69,132	Negligible	Negligible	Negligible
Winter Storm & Freeze	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Flood	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Earthquake**	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
HAZMAT Incident	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Wildfire	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Nuclear Accident	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Terror Threat	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.
**Damage for this hazard was only recorded at the county level. Therefore, damage at the municipal level could not be determined, but it should be noted that municipal losses are not necessarily negligible as the municipalities share in the county-wide damage.

TABLE 6.16 (CONT): ANNUALIZED LOSS FOR WAKE COUNTY*

Event	Raleigh	Rolesville	Wake Forest	Wendell	Zebulon	Wake County	Total
Dam Failure	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Drought	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Erosion	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Extreme Heat	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Hail	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	$450
Hurricane & Tropical Storm**	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	$9,936,000
Landslide	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Lightning	$35,285	Negligible	$3,723	$62,291	Negligible	$21,029	$630,423
Thunderstorm Wind/High Wind[20]	$8,673	Negligible	Negligible	$1,519	$2,518	$5,875	$56,307

[19] The annualized losses for these hazards were combined.
[20] The annualized losses for these hazards were combined.

Event	Raleigh	Rolesville	Wake Forest	Wendell	Zebulon	Wake County	Total
Tornado	$1,197	$54,637	Negligible	$311,795	Negligible	$11,111,453	$11,553,089
Winter Storm & Freeze	Negligible	Negligible	Negligible	Negligible	Negligible	$47,408	$47,408
Flood	$578,710	Negligible	Negligible	Negligible	Negligible	$12,228	$590,938
Earthquake**	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	$119,000
HAZMAT Incident	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Wildfire	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Terror Threat	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
Nuclear Accident	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.
**Damage for this hazard was only recorded at the county level. Therefore, damage at the municipal level could not be determined, but it should be noted that municipal losses are not necessarily negligible as the municipalities share in the county-wide damage.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table 6.17** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

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TABLE 6.17: AT-RISK CRITICAL FACILITIES

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
WAKE COUNTY																								
HOLLY SPRINGS	EMS STATION	X	X	X	X	X	X	X	X	X								X		X		X	X	X
WAKE CROSSROADS	EMS STATION	X	X	X	X	X	X	X	X	X						X	X	X					X	X
STONY HILL	EMS STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
HILLTOP	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
BETHANY CHURCH	EMS STATION	X	X	X	X	X	X	X	X	X													X	X
SIX FORKS NORTH	EMS STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RDU AIRPORT	EMS STATION	X	X	X	X	X	X	X	X	X		X					X	X					X	X
GARNER SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X													X	X
KNIGHTDALE SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X								X					X	X
KNIGHTDALE WEST	EMS STATION	X	X	X	X	X	X	X	X	X							X	X		X			X	X
MINICITY	EMS STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
APEX #2	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
FUQUAY-VARINA #2	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
GARNER #2	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
FAIRVIEW #2	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
FAIRVIEW #1	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
RDU CFR	FIRE STATION	X	X	X	X	X	X	X	X	X		X											X	X
EASTERN WAKE #1	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
HOPKINS	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
WENDELL #2	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
WAKE-NEW HOPE #2	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
FALLS	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
BAY LEAF #1	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
STONY HILL #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
STONY HILL #2	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
BAY LEAF #2	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
DURHAM HIGHWAY #1	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
FUQUAY-VARINA #3	FIRE	X	X	X	X	X	X	X	X	X													X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
	STATION																							
HOLLY SPRINGS #1	FIRE STATION	X	X	X	X	X	X	X	X	X								X		X		X	X	X
HOLLY SPRINGS #2	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
HOLLY SPRINGS #3	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X				X	X	X
RFD #29	FIRE STATION	X	X	X	X	X	X	X	X	X		X						X					X	X
JAMES REST HOME	OTHER	X	X	X	X	X	X	X	X	X		X					X	X				X	X	X
SPRING ARBOR ADULT CARE OF EAST RALEIGH	OTHER	X	X	X	X	X	X	X	X	X							X	X					X	X
WALTONWOOD CARY PARKWAY ADULT CARE	OTHER	X	X	X	X	X	X	X	X	X							X	X					X	X
HOSPICE OF WAKE COUNTY	OTHER	X	X	X	X	X	X	X	X	X							X	X					X	X
SWIFT CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
BRASSFIELD ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
PLEASANT UNION ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
EAST WAKE HS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
CARVER ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
YATES MILL ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
JONES DAIRY ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
EAST WAKE SCHOOL OF HEALTH SCIENCE	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
SMITH ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X		X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
EAST WAKE SCHOOL OF INTEGRATED TECHNOLOGY	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
FRED A. SMITH ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X		X			X	X
VANCE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
APEX																								
APEX MAIN	EMS STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
APEX SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X		X				X	X	X	X	X		X	X	X
APEX #1	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
APEX #2	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
APEX #3	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X		X		X	X	X
APEX #4	FIRE STATION	X	X	X	X	X	X	X	X	X		X				X	X	X	X	X		X	X	X
WAKEMED HEALTHPLEX	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X		X					X	X				X	X	X
TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X		X						X	X	X		X	X	X
PUBLIC WORKS	OTHER	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
WATER RECLAMATION FACILITY	OTHER	X	X	X	X	X	X	X	X	X		X			X	X	X	X	X	X		X	X	X
WATER TREATMENT PLANT	OTHER	X	X	X	X	X	X	X	X	X		X						X	X	X		X	X	X
APEX	POLICE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
APEX ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
APEX HS	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
OLIVE CHAPEL ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X				X	X	X
APEX MS	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
BAUCOM ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
LUFKIN ROAD MS	SCHOOL	X	X	X	X	X	X	X	X	X		X				X	X	X	X	X		X	X	X
SALEM ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
SALEM MS	SCHOOL	X	X	X	X	X	X	X	X	X		X						X	X	X			X	X
APEX FRIENDSHIP HS	SCHOOL	X	X	X	X	X	X	X	X	X		X							X	X		X	X	X
SCOTTS RIDGE ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X		X		X	X	X
CARY																								
CARY MAIN	EMS STATION	X	X	X	X	X	X	X	X	X													X	X
FAIRVIEW	EMS STATION	X	X	X	X	X	X	X	X	X													X	X
CARY WEST	EMS STATION	X	X	X	X	X	X	X	X	X		X							X	X			X	X
CARY SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
MORRISVILLE #3	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
CARY #4	FIRE STATION	X	X	X	X	X	X	X	X	X		X							X	X			X	X
CARY #5	FIRE STATION	X	X	X	X	X	X	X	X	X		X							X	X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
CARY #2	FIRE STATION	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X			X	X
CARY #1	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
SWIFT CREEK	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
CARY #3	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
CARY #6	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
CARY #7	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
CARY #8	FIRE STATION	X	X	X	X	X	X	X	X	X		X						X					X	X
WESTERN WAKE- WAKEMED	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X							X	X					X	X
WESTERN WAKE REGIONAL WATER RECLAMATION FACILITY	OTHER	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
SOUTH CARY WATER RECLAMATION FACILITY	OTHER	X	X	X	X	X	X	X	X	X													X	X
NORTH CARY WATER RECLAMATION FACILITY	OTHER	X	X	X	X	X	X	X	X	X		X					X	X					X	X
SOLID WASTE TRANSFER STATION	OTHER	X	X	X	X	X	X	X	X	X		X						X	X	X			X	X
PUBLIC WORKS OPERATIONS CENTER	OTHER	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
CROSSROAD SUBSTATIONS	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
CARY TOWNE CENTER SUBSTATION	POLICE	X	X	X	X	X	X	X	X	X								X					X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
	STATION																							
CARY (MAIN)	POLICE STATION	X	X	X	X	X	X	X	X	X						X		X	X	X			X	X
SUBSTATION	POLICE STATION	X	X	X	X	X	X	X	X	X		X							X	X			X	X
BRIARCLIFF ES	SCHOOL	X	X	X	X	X	X	X	X	X										X			X	X
FARMINGTON WOODS ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
CARY HS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
ADAMS ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
KINGSWOOD ES	SCHOOL	X	X	X	X	X	X	X	X	X						X		X	X	X			X	X
NORTHWOODS ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
WEST LAKE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
GREEN HOPE HS	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
OAK GROVE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
EAST CARY MS	SCHOOL	X	X	X	X	X	X	X	X	X								X		X			X	X
WEST CARY MS	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X		X			X	X
GREEN HOPE ES	SCHOOL	X	X	X	X	X	X	X	X	X		X						X	X	X			X	X
MIDDLE CREEK HS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
TURNER CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X					X	X
HIGHCROFT DRIVE ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X		X			X	X
DAVIS DRIVE MS	SCHOOL	X	X	X	X	X	X	X	X	X		X							X	X			X	X
DAVIS DRIVE ES	SCHOOL	X	X	X	X	X	X	X	X	X		X							X	X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
PANTHER CREEK HS	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X		X			X	X
CARY ES	SCHOOL	X	X	X	X	X	X	X	X	X									X	X			X	X
WEATHERSTONE ES	SCHOOL	X	X	X	X	X	X	X	X	X		X						X		X			X	X
CARPENTER ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
REEDY CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
REEDY CREEK MS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
HARRIET B WEBSTER AT CROSSROADS II ADM	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
MIDDLE CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
PENNY ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
FUQUAY-VARINA																								
FUQUAY	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
FUQUAY-VARINA #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
SOUTHERN WAKE- WAKEMED	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
TERRIBLE CREEK WWTP	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
BRIGHTON FOREST WWTP	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WINDSOR POINT ASSISTED LIVING	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
FUQUAY-VARINA HOMES FOR THE ELDERLY	OTHER	X	X	X	X	X	X	X	X	X							X	X		X		X	X	X
CARILLON ASSISTED LIVING	OTHER	X	X	X	X	X	X	X	X	X							X	X		X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
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UNIVERSAL HEALTHCARE	OTHER	X	X	X	X	X	X	X	X	X								X	X	X			X	X
FUQUAY-VARINA	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
FUQUAY-VARINA MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
LINCOLN HEIGHTS ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
BALLENTINE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
FUQUAY-VARINA ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
FUQUAY-VARINA HS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
WILLOW SPRINGS ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
BANKS ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
HERBERT AKINS ES	SCHOOL	X	X	X	X	X	X	X	X	X					X	X		X				X	X	X
GARNER																								
GARNER MAIN	EMS STATION	X	X	X	X	X	X	X	X	X						X							X	X
GARNER EAST	EMS STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
GARNER #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
GARNER #3	FIRE STATION	X	X	X	X	X	X	X	X	X						X							X	X
GARNER #4	FIRE STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
PUBLIC WORKS BUILDING	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WATER TREATMENT PLANT	OTHER	X	X	X	X	X	X	X	X	X							X	X					X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
WASTEWATER SPRAY FACILITY	OTHER	X	X	X	X	X	X	X	X	X								X					X	X
GARNER	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
POLICE ANNEX	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
EAST DISTRICT SUBSTATION	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WEST DISTRICT SUBSTATION	POLICE STATION	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X			X	X
POLICE	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
RAND ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
NORTH GARNER MS	SCHOOL	X	X	X	X	X	X	X	X	X								X	X	X			X	X
EAST GARNER MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
EAST GARNER ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
CREECH ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X								X		X			X	X
TIMBER DRIVE ES	SCHOOL	X	X	X	X	X	X	X	X	X						X							X	X
GARNER HS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X		X			X	X
VANDORA SPRINGS ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
AVERSBORO ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
HOLLY SPRINGS																								
PUBLIC WORKS BUILDING	OTHER	X	X	X	X	X	X	X	X	X							X	X		X		X	X	X
TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
WASTEWATER TREATMENT PLANT	OTHER	X	X	X	X	X	X	X	X	X							X	X		X		X	X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
HOLLY SPRINGS	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
LAW ENFORCEMENT CENTER	POLICE STATION	X	X	X	X	X	X	X	X	X								X		X		X	X	X
HOLLY SPRINGS HS	SCHOOL	X	X	X	X	X	X	X	X	X										X		X	X	X
HOLLY SPRINGS ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
HOLLY RIDGE ES	SCHOOL	X	X	X	X	X	X	X	X	X								X				X	X	X
HOLLY RIDGE MS	SCHOOL	X	X	X	X	X	X	X	X	X												X	X	X
HOLLY GROVE ES	SCHOOL	X	X	X	X	X	X	X	X	X								X		X		X	X	X
KNIGHTDALE																								
KNIGHTDALE MAIN	EMS STATION	X	X	X	X	X	X	X	X	X							X	X		X			X	X
EASTERN WAKE #2	FIRE STATION	X	X	X	X	X	X	X	X	X								X	X	X			X	X
KNIGHTDALE PUB SAFETY #2	FIRE STATION	X	X	X	X	X	X	X	X	X								X	X	X			X	X
KNIGHTDALE PUB SAFETY #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X		X			X	X
CARILLON ASSISTED LIVING	OTHER	X	X	X	X	X	X	X	X	X								X					X	X
WELLINGTON NURSING HOME	OTHER	X	X	X	X	X	X	X	X	X							X	X		X			X	X
KNIGHTDALE	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
LOCKHART ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X		X			X	X
EAST WAKE MS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
KNIGHTDALE ES	SCHOOL	X	X	X	X	X	X	X	X	X								X	X	X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
KNIGHTDALE HS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
FORESTVILLE ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
HODGE ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X								X	X	X			X	X
MORRISVILLE																								
MORRISVILLE	EMS STATION	X	X	X	X	X	X	X	X	X		X			X	X	X	X	X	X			X	X
MORRISVILLE #1	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
MORRISVILLE #2	FIRE STATION	X	X	X	X	X	X	X	X	X		X			X	X	X	X	X	X			X	X
TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
MORRISVILLE	POLICE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
MORRISVILLE ES	SCHOOL	X	X	X	X	X	X	X	X	X		X											X	X
CEDAR FORK ES	SCHOOL	X	X	X	X	X	X	X	X	X		X				X	X	X	X	X			X	X
RALEIGH																								
NORTH HILLS	EMS STATION	X	X	X	X	X	X	X	X	X													X	X
WHITAKER MILL	EMS STATION	X	X	X	X	X	X	X	X	X								X	X	X			X	X
FAIRGROUNDS	EMS STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
KNIGHTDALE SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
SIX FORKS MAIN	EMS STATION	X	X	X	X	X	X	X	X	X								X					X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
MINICITY	EMS STATION	X	X	X	X	X	X	X	X	X								X	X	X			X	X
E RALEIGH	EMS STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
DOWNTOWN	EMS STATION	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
DURANT	EMS STATION	X	X	X	X	X	X	X	X	X										X			X	X
WAKE CROSSROADS	EMS STATION	X	X	X	X	X	X	X	X	X								X					X	X
HIGHWOODS	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
ST AUGUSTINES	EMS STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
GLENWOOD SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
CARALEIGH	EMS STATION	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
PLEASANT VALLEY	EMS STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RFD #23	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
RFD #17	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RFD #14	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
WESTERN WAKE #1	FIRE STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
RFD #8	FIRE	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
	STATION																							
RFD #20	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RFD #2	FIRE STATION	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
RFD #10	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
RFD #3	FIRE STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
RFD #5	FIRE STATION	X	X	X	X	X	X	X	X	X									X	X			X	X
RFD #6	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RFD #7	FIRE STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
RFD #12	FIRE STATION	X	X	X	X	X	X	X	X	X						X	X	X					X	X
RFD #18	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
BAY LEAF #3	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
RFD #9	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RFD #4	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
RFD #11	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE-NEW HOPE #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
RFD #19	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
RFD #15	FIRE STATION	X	X	X	X	X	X	X	X	X										X			X	X
RFD #16	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RFD #1	FIRE STATION	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
RFD #21	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
RFD #22	FIRE STATION	X	X	X	X	X	X	X	X	X						X		X	X	X			X	X
RFD #24	FIRE STATION	X	X	X	X	X	X	X	X	X		X				X	X	X					X	X
RFD #25	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
RFD #27	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
RFD #26	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
RFD #28	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
KEETER TRAINING CENTER- FIRE	FIRE STATION	X	X	X	X	X	X	X	X	X			X		X	X	X	X	X	X			X	X
DORTHEA DIX	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X						X		X	X	X			X	X
RCMB- WAKEMED	MEDICAL CARE	X	X	X	X	X	X	X	X	X								X		X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
	FACILITY																							
REX	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X								X					X	X
DUKE RALEIGH	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
PULSTAR REACTOR AT NCSU	OTHER	X	X	X	X	X	X	X	X	X									X	X			X	X
EMJ WWTP	OTHER	X	X	X	X	X	X	X	X	X													X	X
PUBLIC WORKS	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
MUNICIPAL BUILDING- ECC	OTHER	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
NORTHEAST DISTRICT	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
DETECTIVE DIVISION	POLICE STATION	X	X	X	X	X	X	X	X	X									X	X			X	X
SOUTHEAST DISTRICT	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
SOUTHWEST DISTRICT	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
RALEIGH (MAIN)	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
DOWNTOWN DISTRICT	POLICE STATION	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X			X	X
NORTHWEST DISTRICT	POLICE STATION	X	X	X	X	X	X	X	X	X						X	X	X					X	X
MAIN STATION INTERIM	POLICE STATION	X	X	X	X	X	X	X	X	X													X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
NORTH DISTRICT	POLICE STATION	X	X	X	X	X	X	X	X	X													X	X
CRITICAL PUBLIC SAFETY BUILDING	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
POLICE DISTRICT STATION- INTERACT	POLICE STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
POLICE DISTRICT STATION- NE OUTREACH	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
POLICE DISTRICT STATION- NEIGHBORHOOD STATION	POLICE STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
POLICE DISTRICT STATION- MOUNTED POLICE	POLICE STATION	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
POLICE DISTRICT STATION- SERVICE, SPECIAL OPS	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
POLICE TRAINING CENTER	POLICE STATION	X	X	X	X	X	X	X	X	X								X					X	X
COMBS ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
ATHENS DRIVE HS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
BROUGHTON HS	SCHOOL	X	X	X	X	X	X	X	X	X								X	X	X			X	X
POWELL ES	SCHOOL	X	X	X	X	X	X	X	X	X								X		X			X	X
MARY E PHILLIPS HS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
LIGON MS	SCHOOL	X	X	X	X	X	X	X	X	X						X		X		X			X	X
WASHINGTON ES	SCHOOL	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X			X	X
CARNAGE MS	SCHOOL	X	X	X	X	X	X	X	X	X						X		X	X	X			X	X
DANIELS MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
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ROOT ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
LYNN ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
BROOKS ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
CARROLL MS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
DOUGLAS ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
MILLBROOK ES	SCHOOL	X	X	X	X	X	X	X	X	X									X	X			X	X
WILBURN ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
EAST MILLBROOK MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
FOX ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
LEAD MINE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
BUGG ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
DURANT ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X										X			X	X
STOUGH ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
YORK ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
JEFFREYS GROVE ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
SOUTHEAST RALEIGH HS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
ROCK QUARRY SERVICE CENTER	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
BRENTWOOD ES	SCHOOL	X	X	X	X	X	X	X	X	X								X		X			X	X
ENLOE HS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
MILLBROOK HS	SCHOOL	X	X	X	X	X	X	X	X	X									X	X			X	X
NORTH RIDGE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X

FACILITY NAME	FACILITY TYPE	ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
		Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
SANDERSON HS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
WEST MILLBROOK MS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
MARTIN MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
OLDS ES	SCHOOL	X	X	X	X	X	X	X	X	X									X	X			X	X
WILEY ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WILDWOOD FOREST ES	SCHOOL	X	X	X	X	X	X	X	X	X						X	X	X		X			X	X
PARTNERSHIP ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
CENTENNIAL CAMPUS MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
MOORE SQUARE MS	SCHOOL	X	X	X	X	X	X	X	X	X						X	X	X		X			X	X
BAILEYWICK ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
BRIER CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X		X				X	X	X					X	X
DURANT ROAD MS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
HILBURN DRIVE ACADEMY	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
CONN ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
UNDERWOOD ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
MT VERNON SCHOOL	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKEFIELD ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
WAKEFIELD MS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
WAKEFIELD HS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
GREEN ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
HARRIS CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
DILLARD DRIVE MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
DILLARD DRIVE ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
SPRING FOREST ROAD MODULAR	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
NORTH FOREST PINES ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
RIVER OAKS MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X		X			X	X
BARWELL ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
FOREST PINES DRIVE ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
FULLER ES	SCHOOL	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
HUNTER ES	SCHOOL	X	X	X	X	X	X	X	X	X										X			X	X
POE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
LONGVIEW SCHOOL	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
WAKE EARLY COLLEGE OF HEALTH AND SCIENCES	SCHOOL	X	X	X	X	X	X	X	X	X								X	X	X			X	X
ROLESVILLE																								
ROLESVILLE MAIN	EMS STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
ROLESVILLE	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
ROLESVILLE TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X							X	X					X	X
ROLESVILLE	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
ROLESVILLE ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
SANFORD CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
ROLESVILLE HS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
ROLESVILLE MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
WAKE FOREST																								
WAKE FOREST	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST #2	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST #3	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
WAKE FOREST #4	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
WATER TREATMENT PLAN	OTHER	X	X	X	X	X	X	X	X	X							X	X					X	X
TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
SEWER TREATMENT PLANT	OTHER	X	X	X	X	X	X	X	X	X													X	X
PUBLIC WORKS OPERATIONS CENTER	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
CARILLON ASSISTED LIVING	OTHER	X	X	X	X	X	X	X	X	X								X	X	X			X	X
HILLSIDE NURSING CENTER	OTHER	X	X	X	X	X	X	X	X	X							X	X		X			X	X
CAROLINA HOUSE OF WAKE FOREST	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
THE LODGE (ELDERLY HOUSING)	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
TURNBERRY APARTMENTS (ELDERLY HOUSING)	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X

FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
MAIN	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
SUBSTATION TWO	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X		X			X	X
SUBSTATION THREE	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
SUBSTATION FOUR	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST HS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
HERITAGE MS	SCHOOL	X	X	X	X	X	X	X	X	X								X		X			X	X
HERITAGE ES	SCHOOL	X	X	X	X	X	X	X	X	X								X		X			X	X
WAKEFIELD 9TH GRADE CENTER	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
RICHLAND CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
HERITAGE HS	SCHOOL	X	X	X	X	X	X	X	X	X										X			X	X
WENDELL																								
WENDELL	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WENDELL #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WENDELL TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
PUBLIC WORKS- WASTEWATER FACILITY	OTHER	X	X	X	X	X	X	X	X	X								X		X			X	X
CRESTFIELD APTS FOR DISABLED AND	OTHER	X	X	X	X	X	X	X	X	X							X	X		X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
ELDERLY																								
OLIVER HOUSE REST HOME	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
ROBINWOOD APARTMENTS- ELDERLY	OTHER	X	X	X	X	X	X	X	X	X							X	X		X			X	X
CEDAR SPRINGS APARTMENTS- ELDERLY	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WENDELL	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WENDELL ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
LAKE MYRA ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
ZEBULON																								
ZEBULON	FIRE STATION	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
EASTERN WAKE- WAKEMED	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X					X	X	X	X		X			X	X
PUBLIC WORKS	OTHER	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
ZEBULON	POLICE STATION	X	X	X	X	X	X	X	X	X					X	X	X	X		X			X	X
ZEBULON MS	SCHOOL	X	X	X	X	X	X	X	X	X					X	X	X	X		X			X	X
ZEBULON ES	SCHOOL	X	X	X	X	X	X	X	X	X					X	X	X	X					X	X
WAKELON ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X

Secondary Critical Facilities are listed in slight contrast to Critical Facilities as their continued function has not been deemed as critical as primary facilities in the event of a disaster, but these facilities are extremely important. A loss of function to one of these facilities would have a definitively greater negative impact on the community's ability to respond to and recover from a disaster than a loss of function at other facilities/structures within the jurisdiction. In **Table 6.18**, these facilities have been classified as either Significant Community Locations/Sheltering Centers or as Critical Resources Management Facilities. These facilities are all vulnerable to any of the atmospheric hazards and many are also likely vulnerable to other hazards identified above, though no locational analysis was carried out to this end.

TABLE 6.18: WAKE COUNTY SECONDARY CRITICAL FACILITIES

Facility Name	Address*	Type
Apex		
US Post Office	501 W Williams Street	Significant Community Location or Sheltering Center
Dixie Pipeline	1521 E Williams Street	Critical Resources Management (Energy, Water, etc.)
Colonial Pipeline	2200 Ten Ten Road	Critical Resources Management (Energy, Water, etc.)
Motiva Enterprises (refinery)	2232 Ten Ten Road	Critical Resources Management (Energy, Water, etc.)
PSNC High Pressure Station	401 N Mason Street	Critical Resources Management (Energy, Water, etc.)
Gas Pipelines	Dixie, Cardinal, and Colonial	Critical Resources Management (Energy, Water, etc.)
Duke Energy Electric Substations	1324 Wimberly Road; 1406 E Williams Street	Critical Resources Management (Energy, Water, etc.)
Community Center	53 Hunter Street	Significant Community Location or Sheltering Center
Halle Cultural Arts Center	237 N Salem Street	Significant Community Location or Sheltering Center
Cox Airport NC81	off Fern Valley Lane	Significant Community Location or Sheltering Center
John Hertrick [Deck] Air Park	off Air Park Drive	Significant Community Location or Sheltering Center
St. Mary Magdalene Catholic School	625 Magdala Place	Significant Community Location or Sheltering Center
Thales Academy	1177 Ambergate Station	Significant Community Location or Sheltering Center
Eva Perry Regional Library	2100 Shepherds Vineyard Drive	Significant Community Location or Sheltering Center
CC Jones Memorial Park	309 Holleman Street	Significant Community Location or Sheltering Center
NC Department of Corrections	2211 Schieffelin Road	Significant Community Location or Sheltering Center
Chemical Feed Station	1907 Laura Duncan Road	Critical Resources Management (Energy, Water, etc.)
Apex Sanitary Landfill (closed 1976)	451 W Williams Street	Critical Resources Management (Energy, Water, etc.)
Cooper Industries	1000 Lufkin Road	Critical Resources Management (Energy, Water, etc.)
Sorrells Landfill (closed 1994)	5013 Jessie Drive	Critical Resources Management (Energy, Water, etc.)
Water Meter Vaults	• E Williams Street & Sunset Lake Road • Dixie Pipeline • 840 US 64 Highway W • Behind 1040 Vision Drive • 4 Vaults on Eyam Hall Lane • W Williams Street & Jenks Road • The Columns at Broadstone connection to	Critical Resources Management (Energy, Water, etc.)

Facility Name	Address*	Type
	Walmart • 3 Vaults on Creek Glen Way • Olive Chapel Elementary School	
0.5 MGD Water Tower	411 N Mason Street	Critical Resources Management (Energy, Water, etc.)
1.0 MGD Water Tower	91 Hunter Street	Critical Resources Management (Energy, Water, etc.)
1.5 MGD Water Tower	610 Tingen Road	Critical Resources Management (Energy, Water, etc.)
Electric Substation	920 Public Power Drive (formerly accessed from E Williams Street)	Critical Resources Management (Energy, Water, etc.)
Electric Substation	2040 Laura Duncan Road	Critical Resources Management (Energy, Water, etc.)
Electric Substation	2300 Mt. Zion Church Road	Critical Resources Management (Energy, Water, etc.)
Pump Stations	• 1701 ½ Kelly Road (located at 1705 Kelly Road) • 730 ½ Tingen Road (Apex Elementary School) • 1232 ½ Perry Road (1300 Block of Shackleton Road) • 2499 ½ Schieffelin Road • 2422 ½ Watersglen Drive (between 2507 and 2509 Watersglen Drive) • 1016 ½ Camberley Drive • 2025 ½ Production Drive (south of 2026 Production Drive) • 1600 ½ Nasturtium Drive • 4251 ½ Sunset Lake Road (out of sequence) • 6010 Old Smithfield Road • 2525 ½ Lake Pine Road (1800 Block) • 2131 ½ Old Raleigh Road • 1000 ½ East Sterlington Place • 2525 ½ Laura Duncan Road (behind 2209 Candun Drive) • 2731 ½ US 64 Highway West • 814 Homestead Park Drive • 411 ½ Blushing Rose Way • 2080 Laura Duncan Road • 1599 Beaver Creek Commons Drive • 2990 Broadstone Way • 2916 Olive Chapel Road (Town of Cary/Western Wake Partners – Beaver Creek Pump Station) • 3905 Green Level West Road (Town of Cary/Western Wake Partners – West Cary	Critical Resources Management (Energy, Water, etc.)

Facility Name	Address*	Type
	Pump Station) Underlined addresses will need to be re-assigned – see parentheses for explanations	
Cary		
Pump Stations	• West Cary: 3905 Green Level West Road • Morris Branch: 251 Beckingham Loop • Kit Creek: 2605 Green Level Church Road • Beaver Creek: 2916 Olive Chapel Road • Cary/Apex raw Water: 6750 US 64W at Jordan Lake	Critical Resources Management (Energy, Water, etc.)
US Post Office		Significant Community Location or Sheltering Center
Progress Energy		Critical Resources Management (Energy, Water, etc.)
Public Service Company of NC		Critical Resources Management (Energy, Water, etc.)
Bell South		Critical Resources Management (Energy, Water, etc.)
Rex Urgent Care	1515 SW Cary Parkway	Significant Community Location or Sheltering Center
Train Station	211 N. Academy Street	Critical Resources Management (Energy, Water, etc.)
Cary Academy		Significant Community Location or Sheltering Center
Kids Club School		Significant Community Location or Sheltering Center
Lucy Daniels Center		Significant Community Location or Sheltering Center
Shining Star Academy		Significant Community Location or Sheltering Center
Cary Christian School		Significant Community Location or Sheltering Center
Fuquay-Varina		
Town Hall	401 Old Honeycutt Rd.	Significant Community Location or Sheltering Center
Water Pressure Booster Stations	3 locations	Critical Resources Management (Energy, Water, etc.)
Sewer Lift Stations	23 locations	Critical Resources Management (Energy, Water, etc.)
Water Tower	304 Jones Lane	Critical Resources Management (Energy, Water, etc.)
Water Tower	N. Main St	Critical Resources Management (Energy, Water, etc.)
Duke Energy CPL Substations	• Holland Rd (230KV) • Fleming Rd (230KV) • Dickens Rd (115KV)	Critical Resources Management (Energy, Water, etc.)
Public Works Facility		Critical Resources Management (Energy, Water, etc.)
Southern Regional Government Center		Significant Community Location or Sheltering Center
South Park Community Center		Significant Community Location or Sheltering Center
Council Gym		Significant Community Location or Sheltering Center
Johnson House		Historic Location
Wake County Public Library		Significant Community Location or Sheltering Center
Hilltop Christian School	Inside Hilltop Church	Significant Community Location or Sheltering Center

Facility Name	Address*	Type
Southern Wake Academy		Significant Community Location or Sheltering Center
Garner		
Water Tower	140 Rand Mill Road	Critical Resources Management (Energy, Water, etc.)
Water Tower	121 Penny Street	Critical Resources Management (Energy, Water, etc.)
Water Tower	840 East Garner Road	Critical Resources Management (Energy, Water, etc.)
Water Booster Stations	• 2045 W. Garner Road • 501 Mechanical Blvd. • 4567 Jones Sausage Road	Critical Resources Management (Energy, Water, etc.)
Pumping Stations	• 2775 Benson Road • 2390 Aversboro Road • 205 Inkster Cove • 319 St Mellion St • 781 E. Garner Road • 221 E. Garner Road • 1018 N. Spring Garden • 1203 Claymore Drive • 2355 Benson Road • 921 Buffaloe Road • 695 Maxwell Drive • Ten Ten Road and Hwy 401 • 1301 ½ US Hwy 70 • 3960 Junction Road • 2301 Buffaloe Road • 600 Wilton Meadow Road • 5480 Raynor Road • 116 Coassack Circle	Critical Resources Management (Energy, Water, etc.)
US Post Office		Significant Community Location or Sheltering Center
Duke Progress Energy		Critical Resources Management (Energy, Water, etc.)
Duke Progress Energy Central Warehouse/Operations Center		Critical Resources Management (Energy, Water, etc.)
BellSouth		Critical Resources Management (Energy, Water, etc.)
Senior Citizen Center		Significant Community Location or Sheltering Center
Avery Street Recreation Center		Significant Community Location or Sheltering Center
Holly Springs		
Booster Pump Maintenance Building	Utley Creek	Critical Resources (Energy, Water, etc.)
Elevated Water Storage Tank	1136 Avent Ferry Road	Critical Resources Management (Energy, Water, etc.)
Elevated Water Storage Tank	521 Lee St	Critical Resources Management (Energy, Water, etc.)
Elevated Water Storage Tank	401 Holly Springs Rd	Critical Resources Management (Energy, Water, etc.)

Facility Name	Address*	Type
Reclaimed Water Storage Tank	Irving Parkway	Critical Resources Management (Energy, Water, etc.)
Sewer Pump Stations	21 locations	Critical Resources Management (Energy, Water, etc.)
US Post Office		
PSNC Energy Gas Terminal		Critical Resources Management (Energy, Water, etc.)
Duke Progress Energy		Critical Resources Management (Energy, Water, etc.)
BellSouth		Critical Resources Management (Energy, Water, etc.)
Sprint		Critical Resources Management (Energy, Water, etc.)
Solid Waste Facility		Critical Resources Management (Energy, Water, etc.)
W.E. Hunt Community Center/Gym		Significant Community Location or Sheltering Center
Bass Lake Retreat Center		Significant Community Location or Sheltering Center
Holly Springs Cultural Center		Significant Community Location or Sheltering Center
Knightdale		
Recreation Center	101 Lawson Rd	Significant Community Location or Sheltering Center
Old Town Recreation Center	426 N. First Ave	Significant Community Location or Sheltering Center
Track Out Camp at Harper Park	209 Main Street	Significant Community Location or Sheltering Center
Knightdale Swim Club Clubhouse	202 Milburnie Rd	Significant Community Location or Sheltering Center
0.5 MGD Water Tank	7429 Knightdale Blvd	Critical Resources Management (Energy, Water, etc.)
1.0 MDG Water Tank	7429 Knightdale Blvd	Critical Resources Management (Energy, Water, etc.)
Water Booster Pump Stations	• Knightdale Blvd • Forestville Blvd	Critical Resources Management (Energy, Water, etc.)
Sanitary Sewer Pump Stations	• Poole Rd/Neuse • Poplar Cr. Village • Square D • Town Hall • Harper St • Oakwood Acres • Poole Rd/Poplar Cr • Langston Ridge (proposed)	Critical Resources Management (Energy, Water, etc.)
Gas Feeder Line	Knightdale Blvd	Critical Resources Management (Energy, Water, etc.)
Bell South Building	100 Forest Drive	Critical Resources Management (Energy, Water, etc.)
East Wake Library	946 Steeple Square Court	Significant Community Location or Sheltering Center
Angelica's Childcare Center	1305 Oak Crest Drive	Significant Community Location or Sheltering Center
Cathy Lee Child Development Center	529 Bethlehem Road	Significant Community Location or Sheltering Center
Cora's Caring Hands	106 Thomas Place	Significant Community Location or Sheltering Center
Forestville Elementary Before/After School Care	100 Lawson Ridge Road	Significant Community Location or Sheltering Center
Grow-N-Learn Child Care Center	1002 Mulford Court	Significant Community Location or Sheltering Center
Hodge Rd Elementary Before and After School Program	2129 Mingo Bluff Blvd	Significant Community Location or Sheltering Center

Facility Name	Address*	Type
Jenette's Quality Care	111 Satterwhite Drive	Significant Community Location or Sheltering Center
Kid's Palace Home Child Care	942 Widewaters Parkway	Significant Community Location or Sheltering Center
Kids Educational Center IV, Inc.	7106 Forestville Road	Significant Community Location or Sheltering Center
Kids Educational Center	4605 Old Faison Road	Significant Community Location or Sheltering Center
Kindercare Learning Centers LLC	200 Forest Dr	Significant Community Location or Sheltering Center
Knightdale Christian Childcare Center	7114 Knightdale Blvd, Suite A	Significant Community Location or Sheltering Center
Ma Ma Jo's Day Care	301 Park Ave	Significant Community Location or Sheltering Center
Pride and Joy Day Care	1209 Shakentown St.	Significant Community Location or Sheltering Center
Showers of Blessings Childcare	5116 Dantonville Ct.	Significant Community Location or Sheltering Center
The Growing Child Unlimited, Inc.	1005 Big Oak Court	Significant Community Location or Sheltering Center
Widewaters Learning Center	9565 Village Park Dr.	Significant Community Location or Sheltering Center
N.G. House Store	221 N. First Ave	Significant Community Location or Sheltering Center
Henry H. Knight Farm	7045 Knightdale Blvd	Significant Community Location or Sheltering Center
Midway Plantation	1900 Amethyst Ridge Drive	Significant Community Location or Sheltering Center
Beaver Dam Plantation	7081 Forestville Rd	Significant Community Location or Sheltering Center
Morrisville		
Sterling Montessori School	2020 Treybrooke Drive	Significant Community Location or Sheltering Center
Parks and Recreation Administration Building	240 Town Hall Drive	Significant Community Location or Sheltering Center
Public Works	414 Aviation Parkway	Critical Resources Management (Energy, Water, etc.)
Cedar Fork Community Center	1050 B Town Hall Drive	Significant Community Location or Sheltering Center
Raleigh		
Dillon Building	W. Martin	Significant Community Location or Sheltering Center
Anderson Pointe	Anderson Point Dr	Significant Community Location or Sheltering Center
Apollo Heights	Lunar Dr	Significant Community Location or Sheltering Center
Barwell Rd. Park	Barwell Rd.	Significant Community Location or Sheltering Center
Biltmore Hills community Center	Fitzgerald Dr	Significant Community Location or Sheltering Center
Brentwood Park	Vinson Place	Significant Community Location or Sheltering Center
Bufflaloe Rd Park	Buffaloe Rd	Significant Community Location or Sheltering Center
Carolina Pines Community Center	Lake Wheeler Rd	Significant Community Location or Sheltering Center
Chavis	Holmes St	Significant Community Location or Sheltering Center
Downtown Remote operation - F&O	Brentwood Rd	Significant Community Location or Sheltering Center
Durant Campbell Lodge	Durant Rd	Significant Community Location or Sheltering Center
Eastgate	Quail Hollow Dr	Significant Community Location or Sheltering Center
Fayetteville St Mall	Fayetteville St Mall	Significant Community Location or Sheltering Center
Fletcher Borden Building	Clay St.	Significant Community Location or Sheltering Center
Fletcher Park Garris Building	Clay St.	Significant Community Location or Sheltering Center
Glen Eden	Glen Eden Dr	Significant Community Location or Sheltering Center

Facility Name	Address*	Type
Green Rd	Green Rd	Significant Community Location or Sheltering Center
Greystone Recreation Center	Leadmine Rd	Significant Community Location or Sheltering Center
Halifax Park	Halifax St	Significant Community Location or Sheltering Center
Horseshoe Farm old house	Horse Shoe Farm Rd	Significant Community Location or Sheltering Center
Jaycee Community Center	Wade Ave	Significant Community Location or Sheltering Center
John P Top Greene Community Ctr	Martin Luther King Jr Blvd	Significant Community Location or Sheltering Center
Kiwanis Park	Noble Rd	Significant Community Location or Sheltering Center
Lake Johnson - Waterfront, Concession, Bathhouse	Avent Ferry Rd	Significant Community Location or Sheltering Center
Lake Lynn Community Center	Ray Rd	Significant Community Location or Sheltering Center
Lake Wheeler Waterfront Center	Lake Wheeler Rd	Significant Community Location or Sheltering Center
Laurel Hills Community Center	Edward Mills Rd	Significant Community Location or Sheltering Center
Lions Community Center	Dennis Ave	Significant Community Location or Sheltering Center
Marsh Creek Maintenance Facility Admin	Daly Rd	Significant Community Location or Sheltering Center
Marsh Creek Maintenance Facility Head House	Daly Rd	Significant Community Location or Sheltering Center
Marsh Creek Park Community Center	New Hope Rd	Significant Community Location or Sheltering Center
Method Community Center	Method Rd	Significant Community Location or Sheltering Center
Millbrook Community Center	Spring Forest Rd	Significant Community Location or Sheltering Center
Andrew Johnson Birthplace	Mimosa St	Significant Community Location or Sheltering Center
Mordecai House	Mimosa St	Significant Community Location or Sheltering Center
One Exchange Plaza	Fayetteville St	Significant Community Location or Sheltering Center
Optimist Community Center	Whittier Dr	Significant Community Location or Sheltering Center
Peach Rd Neighborhood Center	Peach Rd	Significant Community Location or Sheltering Center
Police Department Cabarrus	W Cabarrus St	Significant Community Location or Sheltering Center
Powell Dr	Powell Dr	Significant Community Location or Sheltering Center
Service Garage - VFS	New Bern Ave	Critical Resources Management (Energy, Water, etc.)
Bus Garage - Radio shop	S Blount St	Critical Resources Management (Energy, Water, etc.)
H.E. Repair Fac - VFS	New Bern Ave	Critical Resources Management (Energy, Water, etc.)
Public Works Tech Shop	S Wilmington St	Critical Resources Management (Energy, Water, etc.)
Butler Bldg- Public Works	S Wilmington St	Critical Resources Management (Energy, Water, etc.)
Peace St- Public Works	W. Peace St., 9	Critical Resources Management (Energy, Water, etc.)
Salt Storage	Dortch St.	Critical Resources Management (Energy, Water, etc.)
Vehicle Fleet Services	N. West St., 4120 New Bern Ave.	Critical Resources Management (Energy, Water, etc.)
Heavy Equipment Facility- Public Works	new Bern Ave	Critical Resources Management (Energy, Water, etc.)
Pullen Park Community Center	Ashe Ave	Significant Community Location or Sheltering Center
Theatre in the Park	Pullen Rd	Significant Community Location or Sheltering Center
Raleigh Little Theatre	Pogue St	Significant Community Location or Sheltering Center
Roberts Community Ctr	E Martin St	Significant Community Location or Sheltering Center

Facility Name	Address*	Type
Sanderford Neighborhood Center	Sanderford Rd	Significant Community Location or Sheltering Center
Southgate Neighborhood Center	Proctor Rd	Significant Community Location or Sheltering Center
Shelly / Sertoma Arts Center	West Millbrook Rd	Significant Community Location or Sheltering Center
Solid Waste Services Scale House	Corporate Prkwy	Critical Resources Management (Energy, Water, etc.)
Solid Waste Services Scale House	N New Hope Rd	Critical Resources Management (Energy, Water, etc.)
Solid Waste Services Yard Waste	New Hope Rd	Critical Resources Management (Energy, Water, etc.)
Solid Waste Services Transfer Station	Corporate Prkwy	Critical Resources Management (Energy, Water, etc.)
Tarboro Rd Community Center	Tarboro Rd	Significant Community Location or Sheltering Center
Tucker House	North Person St	Significant Community Location or Sheltering Center
Walnut Creek Wetland Community Ctr	Peterson St	Significant Community Location or Sheltering Center
Adminstration Bldg - Wilder's Grove – Remote Operations Center	Beacon Lake Dr	Significant Community Location or Sheltering Center
Worthdale Community Center	Cooper Rd	Significant Community Location or Sheltering Center
Brier Creek Community Ctr	Globe Rd	Significant Community Location or Sheltering Center
Raleigh Convention Center	500 S Salisbury St	Significant Community Location or Sheltering Center
Red Hat Ampitheater	500 S McDowell St	Significant Community Location or Sheltering Center
Rolesville		
US Post Office		Significant Community Location or Sheltering Center
Water Booster Station	Bowling Street	Critical Resources Management (Energy, Water, etc.)
Sewer Pump Station	Averett at Jones Dairy	Critical Resources Management (Energy, Water, etc.)
Water Tower	730 South Main Street	Critical Resources Management (Energy, Water, etc.)
Wake Forest		
Community House	133 West Owen Ave	Significant Community Location or Sheltering Center
Alston-Massenburg Recreation Center	416 Taylor St	Significant Community Location or Sheltering Center
Flaherty Park Center	North White Street	Significant Community Location or Sheltering Center
Electric Substation	West Cedar Ave	Critical Resources Management (Energy, Water, etc.)
Wake Forest Urgent Care		Significant Community Location or Sheltering Center
Fast Med		Significant Community Location or Sheltering Center
Public Service Company of NC		Critical Resources Management (Energy, Water, etc.)
Century Link Phone Service		Critical Resources Management (Energy, Water, etc.)
Wake Forest Power		Critical Resources Management (Energy, Water, etc.)
Duke Energy		Critical Resources Management (Energy, Water, etc.)
Wake Electric Membership Corporation		Critical Resources Management (Energy, Water, etc.)
Holding Oil Company		Critical Resources Management (Energy, Water, etc.)
Cruziers		Critical Resources Management (Energy, Water, etc.)
The Learning Experience		Significant Community Location or Sheltering Center
Wake Forest Child Care Center		Significant Community Location or Sheltering Center

Facility Name	Address*	Type
Children's Adventure		Significant Community Location or Sheltering Center
Primrose School of Heritage		Significant Community Location or Sheltering Center
Goddard School		Significant Community Location or Sheltering Center
Wake Forest Kids-R-Kids		Significant Community Location or Sheltering Center
Kids Educational Center		Significant Community Location or Sheltering Center
Heritage Children's Academy		Significant Community Location or Sheltering Center
Rising Star Christian Academy		Significant Community Location or Sheltering Center
Wake Forest Baptist Church		Significant Community Location or Sheltering Center
St. John's Episcopal Church		Significant Community Location or Sheltering Center
Hope Lutheran Church		Significant Community Location or Sheltering Center
Wake Forest Presbyterian Church		Significant Community Location or Sheltering Center
St. Catherine of Siena Early Childhood Center		Significant Community Location or Sheltering Center
Thales Academy		Significant Community Location or Sheltering Center
Endeavor Charter School		Significant Community Location or Sheltering Center
Wake Forest Charter Academy		Significant Community Location or Sheltering Center
Franklin Academy		Significant Community Location or Sheltering Center
St. Catherine's School		Significant Community Location or Sheltering Center
Southeastern Baptist Seminary		Significant Community Location or Sheltering Center
Dubois Center		Significant Community Location or Sheltering Center
Boys and Girls Club		Significant Community Location or Sheltering Center
US Post Office		Significant Community Location or Sheltering Center
Wake Forest Library		Significant Community Location or Sheltering Center
Wakefields		Significant Community Location or Sheltering Center
Glen Royall Apartments		Significant Community Location or Sheltering Center
Calvin Jones House		Significant Community Location or Sheltering Center
I.O. Jones House		Significant Community Location or Sheltering Center
Forestville Baptist Church		Significant Community Location or Sheltering Center
Oak Forest		Significant Community Location or Sheltering Center
Hartsfield House		Significant Community Location or Sheltering Center
Purefoy-Dunn House		Significant Community Location or Sheltering Center
Crenshaw Hall		Significant Community Location or Sheltering Center
Community House		Significant Community Location or Sheltering Center
Purefoy-Chappell House		Significant Community Location or Sheltering Center
Powell House		Significant Community Location or Sheltering Center
Wendell		
Wendell Community Center	601 W. Third Street	Significant Community Location or Sheltering Center
0.5 MGD Water Tank	Poplar Street	Critical Resources Management (Energy, Water, etc.)

Facility Name	Address*	Type
0.75 MGD Water Tank	Chevrolet Way	Critical Resources Management (Energy, Water, etc.)
Water booster Pump Stations	• Liles Dean Road • Old Zebulon Road	Critical Resources Management (Energy, Water, etc.)
Water or Sewer Meter Stations		Critical Resources Management (Energy, Water, etc.)
Sanitary Sewer Pump Stations		Critical Resources Management (Energy, Water, etc.)
Waterlines		Critical Resources Management (Energy, Water, etc.)
Sewer lines		Critical Resources Management (Energy, Water, etc.)
Southern Bell	104 N. Pine Street	Critical Resources Management (Energy, Water, etc.)
Wendell Public Library	207 S. Hollybrook Rd	Significant Community Location or Sheltering Center
US Post Office	40 Hanor Ln	Significant Community Location or Sheltering Center
ABC Land Child Care I	610 Raymond Dr	Significant Community Location or Sheltering Center
ABC Land Child Care II	55 Liles Dean Rd	Significant Community Location or Sheltering Center
Eastern Wake Senior Center	323 Lake Drive	Significant Community Location or Sheltering Center
Parhams Day Care	4690 Wendell Blvd	Significant Community Location or Sheltering Center
Wendell Baptist Church Day Care	3651 Wendell Blvd	Significant Community Location or Sheltering Center
Wendell Commercial Historic District	Downtown Wendell	Significant Community Location or Sheltering Center
Zebulon		
Community Center	301 S. Arendell Ave	Significant Community Location or Sheltering Center
Bell South Phone Service		Critical Resources Management (Energy, Water, etc.)
Duke Progress Energy		Critical Resources Management (Energy, Water, etc.)
Public Service of North Carolina		Critical Resources Management (Energy, Water, etc.)
Water, Sewer, Reuse by City of Raleigh		Critical Resources Management (Energy, Water, etc.)
Wake County Public Library- Zebulon		Significant Community Location or Sheltering Center
Mudcat Baseball Stadium		Significant Community Location or Sheltering Center
Wake County Eastern Regional Center		Significant Community Location or Sheltering Center
Coventry House		Significant Community Location or Sheltering Center
Zebulon Charter School		Significant Community Location or Sheltering Center
Yarborough-O'Neal Villa		Significant Community Location or Sheltering Center
Zebulon Post		Significant Community Location or Sheltering Center

**Some address information could not be provided or was not applicable to the facility*

SECTION 7
CAPABILITY ASSESSMENT

This section of the Plan discusses the capability of the jurisdictions in Wake County to implement hazard mitigation activities. It consists of the following four subsections:

- 7.1 What is a Capability Assessment?
- 7.2 Conducting the Capability Assessment
- 7.3 Capability Assessment Findings
- 7.4 Conclusions on Local Capability

7.1 WHAT IS A CAPABILITY ASSESSMENT

The purpose of conducting a capability assessment is to determine the ability of a local jurisdiction to implement a comprehensive mitigation strategy and to identify potential opportunities for establishing or enhancing specific mitigation policies, programs, or projects[1]. As in any planning process, it is important to try to establish which goals, objectives, and/or actions are feasible based on an understanding of the organizational capacity of those agencies or departments tasked with their implementation. A capability assessment helps to determine which mitigation actions are practical, and likely to be implemented over time, given a local government's planning and regulatory framework, level of administrative and technical support, amount of fiscal resources, and current political climate.

A capability assessment has two primary components: 1) an inventory of a local jurisdiction's relevant plans, ordinances, or programs already in place and 2) an analysis of its capacity to carry them out. Careful examination of local capabilities will detect any existing gaps, shortfalls, or weaknesses with ongoing government activities that could hinder proposed mitigation activities and possibly exacerbate community hazard vulnerability. A capability assessment also highlights the positive mitigation measures already in place or being implemented at the local government level, which should continue to be supported and enhanced through future mitigation efforts.

The capability assessment completed for Wake County and its municipalities serves as a critical planning step and an integral part of the foundation for designing an effective hazard mitigation strategy. Coupled with the Risk Assessment, the Capability Assessment helps identify and target meaningful mitigation actions for incorporation in the Mitigation Strategy portion of the Hazard Mitigation Plan. It not only helps establish the goals and objectives for the region to pursue under this Plan, but it also ensures that those goals and objectives are realistically achievable under given local conditions.

[1] While the Final Rule for implementing the Disaster Mitigation Act of 2000 does not require a local capability assessment to be completed for local hazard mitigation plans, it is a critical step in developing a mitigation strategy that meets the needs of the region while taking into account their own unique abilities. The Rule does state that a community's mitigation strategy should be "based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools" (44 CFR, Part 201.6(c)(3)).

7.2 CONDUCTING THE CAPABILITY ASSESSMENT

In order to facilitate the inventory and analysis of local government capabilities for Wake County and its municipalities, a detailed Capability Assessment Survey was completed for each of the participating jurisdictions based on the information found in existing hazard mitigation plans and local government websites. The survey questionnaire compiled information on a variety of "capability indicators" such as existing local plans, policies, programs, or ordinances that contribute to and/or hinder the jurisdictions' ability to implement hazard mitigation actions. Other indicators included information related to the communities' fiscal, administrative, and technical capabilities, such as access to local budgetary and personnel resources for mitigation purposes. The current political climate, an important consideration for any local planning or decision making process, was also evaluated with respect to hazard mitigation.

At a minimum, survey results provide an extensive inventory of existing local plans, ordinances, programs, and resources that are in place or under development in addition to their overall effect on hazard loss reduction. However, the survey instrument can also serve to identify gaps, weaknesses, or conflicts that counties and local jurisdictions can recast as opportunities for specific actions to be proposed as part of the hazard mitigation strategy.

The information collected in the survey questionnaire was incorporated into a database for further analysis. A general scoring methodology[2] was then applied to quantify each jurisdiction's overall capability. According to the scoring system, each capability indicator was assigned a point value based on its relevance to hazard mitigation

Using this scoring methodology, a total score and an overall capability rating of "high," "moderate," or "limited" could be determined according to the total number of points received. These classifications are designed to provide nothing more than a general assessment of local government capability. The results of this capability assessment provide critical information for developing an effective and meaningful mitigation strategy.

7.3 CAPABILITY ASSESSMENT FINDINGS

The findings of the capability assessment are summarized in this Plan to provide insight into the relevant capacity of the jurisdictions in Wake County to implement hazard mitigation activities. All information is based upon the review of existing hazard mitigation plans and local government websites through the Capability Assessment Survey and input provided by local government officials during meetings of the Wake County Regional Work Groups.

7.3.1 Planning and Regulatory Capability

Planning and regulatory capability is based on the implementation of plans, ordinances, and programs that demonstrate a local jurisdiction's commitment to guiding and managing growth, development, and redevelopment in a responsible manner while maintaining the general welfare of the community. It includes emergency response and mitigation planning, comprehensive land use planning, and transportation planning; the enforcement of zoning or subdivision ordinances and building codes that regulate how land is developed and structures are built; as well as protecting environmental, historic, and cultural resources in the community. Although some conflicts can arise, these planning initiatives

[2] The scoring methodology used to quantify and rank the jurisdictions' capability can be found in Appendix B.

generally present significant opportunities to integrate hazard mitigation principles and practices into the local decision making process.

This assessment is designed to provide a general overview of the key planning and regulatory tools and programs that are in place or under development for the jurisdictions in Wake County along with their potential effect on loss reduction. This information will help identify opportunities to address existing gaps, weaknesses, or conflicts with other initiatives in addition to integrating the implementation of this Plan with existing planning mechanisms where appropriate.

Table 7.1 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the jurisdictions in Wake County. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE 7.1: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning / Regulatory Tool	WAKE COUNTY	Apex	Cary	Fuquay-Varina	Garner	Holly Springs	Knightdale	Morrisville	Raleigh	Rolesville	Wake Forest	Wendell	Zebulon
Hazard Mitigation Plan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Comprehensive Land Use Plan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Floodplain Management Plan	✓												
Open Space Management Plan (Parks & Rec/Greenway Plan)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stormwater Management Plan/Ordinance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Natural Resource Protection Plan													
Flood Response Plan	✓			✓									
Emergency Operations Plan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Continuity of Operations Plan	✓		✓		✓			✓					
Evacuation Plan													
Disaster Recovery Plan													*
Capital Improvements Plan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Economic Development Plan	✓		✓	✓					✓		✓	✓	
Historic Preservation Plan	✓		✓								✓		
Flood Damage Prevention Ordinance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Planning / Regulatory Tool	WAKE COUNTY	Apex	Cary	Fuquay-Varina	Garner	Holly Springs	Knightdale	Morrisville	Raleigh	Rolesville	Wake Forest	Wendell	Zebulon
Zoning Ordinance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Subdivision Ordinance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Unified Development Ordinance	✓	✓	✓	*	✓	✓	✓	*	✓	✓	✓	✓	*
Post-Disaster Redevelopment Ordinance													
Building Code	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fire Code	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
National Flood Insurance Program (NFIP)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
NFIP Community Rating System									✓				

A more detailed discussion on the county's planning and regulatory capability follows.

7.3.2 Emergency Management

Hazard mitigation is widely recognized as one of the four primary phases of emergency management. The three other phases include preparedness, response, and recovery. In reality, each phase is interconnected with hazard mitigation, as **Figure 7.1** suggests. Opportunities to reduce potential losses through mitigation practices are most often implemented before disaster strikes, such as the elevation of flood prone structures or the continuous enforcement of policies that prevent and regulate development that is vulnerable to hazards due to its location, design, or other characteristics. Mitigation opportunities will also be presented during immediate preparedness or response activities, such as installing storm shutters in advance of a hurricane, and certainly during the long-term recovery and redevelopment process following a hazard event.

FIGURE 7.1: THE FOUR PHASES OF EMERGENCY MANAGEMENT

Planning for each phase is a critical part of a comprehensive emergency management program and a key to the successful implementation of hazard mitigation actions. As a result, the Capability Assessment Survey asked several questions across a range of emergency management plans in order to assess the participating jurisdictions' willingness to plan and their level of technical planning proficiency.

Hazard Mitigation Plan: A hazard mitigation plan represents a community's blueprint for how it intends to reduce the impact of natural and human-caused hazards on people and the built environment. The essential elements of a hazard mitigation plan include a risk assessment, capability assessment, and mitigation strategy.

- Wake County and all 12 incorporated municipalities have previously adopted hazard mitigation plans. Prior to this planning effort, each participating jurisdiction had a single-jurisdiction plan.

Disaster Recovery Plan: A disaster recovery plan serves to guide the physical, social, environmental, and economic recovery and reconstruction process following a disaster. In many instances, hazard mitigation principles and practices are incorporated into local disaster recovery plans with the intent of capitalizing on opportunities to break the cycle of repetitive disaster losses. Disaster recovery plans can also lead to the preparation of disaster redevelopment policies and ordinances to be enacted following a hazard event.

- Zebulon is the only jurisdiction in the County that is working on a disaster recovery plan. The remaining jurisdictions should consider developing a plan to guide the recovery and reconstruction process following a disaster.

Emergency Operations Plan: An emergency operations plan outlines responsibilities and the means by which resources are deployed during and following an emergency or disaster.

- Wake County maintains an emergency operations plan through the County Emergency Management Department. All 12 incorporated municipalities have adopted the county plan.
- The following incorporated municipalities have also adopted municipal-level emergency operations plans: Apex, Cary, Fuquay-Varina, Garner, Knightdale, Morrisville, Raleigh, and Wake Forest.

Continuity of Operations Plan: A continuity of operations plan establishes a chain of command, line of succession, and plans for backup or alternate emergency facilities in case of an extreme emergency or disaster event.

- Wake County has adopted a continuity of operations plan (COOP). In 2010, three COOP training sessions and one executive-level tabletop exercise were conducted.
- The Towns of Cary, Garner, and Morrisville have each adopted a municipal-level continuity of operations plan.

Flood Response Plan: A flood response plan establishes procedures for responding to a flood emergency including coordinating and facilitating resources to minimize the impacts of flood.

- Although Wake County does not include a specific Annex to the Emergency Operations Plan that addresses flood response, the Basic Plan portion of the Emergency Operations Plan does discuss flooding and establishes the structure, methodology, and mechanisms to respond to a flooding incident.
- The Town of Fuquay-Varina is the only jurisdiction that has adopted a flood response plan.

7.3.3 General Planning

The implementation of hazard mitigation activities often involves agencies and individuals beyond the emergency management profession. Stakeholders may include local planners, public works officials, economic development specialists, and others. In many instances, concurrent local planning efforts will help to achieve or complement hazard mitigation goals, even though they are not designed as such. Therefore, the Capability Assessment Survey also asked questions regarding general planning capabilities and the degree to which hazard mitigation is integrated into other on-going planning efforts in Wake County.

Comprehensive Land Use Plan: A comprehensive land use plan establishes the overall vision for what a community wants to be and serves as a guide for future governmental decision making. Typically a comprehensive plan contains sections on demographic conditions, land use, transportation elements, and community facilities. Given the broad nature of the plan and its regulatory standing in many communities, the integration of hazard mitigation measures into the comprehensive plan can enhance the likelihood of achieving risk reduction goals, objectives, and actions.

- Wake County has adopted a county land use plan as well as a growth management strategy.
- Each of the 12 incorporated municipalities has adopted a comprehensive land use plan.

Capital Improvements Plan: A capital improvements plan guides the scheduling of spending on public improvements. A capital improvements plan can serve as an important mechanism for guiding future development away from identified hazard areas. Limiting public spending in hazardous areas is one of the most effective long-term mitigation actions available to local governments.

- Wake County and all 12 incorporated municipalities have capital improvement plans in place.

Historic Preservation Plan: A historic preservation plan is intended to preserve historic structures or districts within a community. An often overlooked aspect of the historic preservation plan is the assessment of buildings and sites located in areas subject to natural hazards and the identification of ways to reduce future damages. This may involve retrofitting or relocation techniques that account for the need to protect buildings that do not meet current building standards or are within a historic district that cannot easily be relocated out of harm's way.

- Wake County has a Strategic Plan for Historic Preservation in place. The Towns of Cary and Wake Forest also have each adopted this historic preservation plan.

Zoning Ordinance: Zoning represents the primary means by which land use is controlled by local governments. As part of a community's police power, zoning is used to protect the public health, safety, and welfare of those in a given jurisdiction that maintains zoning authority. A zoning ordinance is the mechanism through which zoning is typically implemented. Since zoning regulations enable municipal governments to limit the type and density of development, a zoning ordinance can serve as a powerful tool when applied in identified hazard areas.

- Wake County and all 12 incorporated municipalities have adopted zoning ordinances.
- The County, Apex, Cary, Garner, Holly Springs, Knightdale, Morrisville, Raleigh, Rolesville, Wake Forest, and Wendell include zoning regulations as part of their local unified development ordinance.
- Fuquay-Varina, and Zebulon have adopted standalone zoning ordinances; however, both municipalities are currently in the process of developing a local unified development ordinance.

Subdivision Ordinance: A subdivision ordinance is intended to regulate the development of residential, commercial, industrial, or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development. Subdivision design that accounts for natural hazards can dramatically reduce the exposure of future development.

- Wake County and all 12 incorporated municipalities have adopted subdivision ordinances.
- The County, Apex, Cary, Garner, Holly Springs, Knightdale, Morrisville, Raleigh, Rolesville, Wake Forest, and Wendell include subdivision regulations as part of their local unified development ordinance.
- Fuquay-Varina, and Zebulon have adopted standalone subdivision ordinances; however, all both municipalities are currently in the process of developing a local unified development ordinance.

Building Codes, Permitting, and Inspections: Building codes regulate construction standards. In many communities, permits and inspections are required for new construction. Decisions regarding the adoption of building codes (that account for hazard risk), the type of permitting process required both before and after a disaster, and the enforcement of inspection protocols all affect the level of hazard risk faced by a community.

- North Carolina has a state compulsory building code, which applies throughout the state; however, jurisdictions may adopt codes if approved as providing adequate minimum standards. The County and all 12 incorporated municipalities have adopted a building code.
- Wake County provides building inspection services for all unincorporated areas of the County and through contractual agreements for the Towns of Knightdale, Rolesville, Wendell, and Zebulon.

- Apex, Cary, Fuquay-Varina, Garner, Holly Springs, Morrisville, Raleigh, and Wake Forest are responsible for enforcement of the building codes within their planning jurisdiction.

The adoption and enforcement of building codes by local jurisdictions is routinely assessed through the Building Code Effectiveness Grading Schedule (BCEGS) program developed by the Insurance Services Office, Inc. (ISO).[3] In North Carolina, the North Carolina Department of Insurance assesses the building codes in effect in a particular community and how the community enforces its building codes *with special emphasis on mitigation of losses from natural hazards*. The results of BCEGS assessments are routinely provided to ISO's member private insurance companies, which in turn may offer ratings credits for new buildings constructed in communities with strong BCEGS classifications. The concept is that communities with well-enforced, up-to-date codes should experience fewer disaster-related losses and, as a result, should have lower insurance rates.

In conducting the assessment, ISO collects information related to personnel qualification and continuing education as well as the number of inspections performed per day. This type of information combined with local building codes is used to determine a grade for that jurisdiction. The grades range from 1 to 10 with a BCEGS grade of 1 representing exemplary commitment to building code enforcement and a grade of 10 indicating less than minimum recognized protection.

Specific BCEGS rating for the participating jurisdictions can be obtained by contacting the department for building inspections within that jurisdiction.

7.3.4 Floodplain Management

Flooding represents the greatest natural hazard facing the nation. At the same time, the tools available to reduce the impacts associated with flooding are among the most developed when compared to other hazard-specific mitigation techniques. In addition to approaches that cut across hazards such as education, outreach, and the training of local officials, the *National Flood Insurance Program* (NFIP) contains specific regulatory measures that enable government officials to determine where and how growth occurs relative to flood hazards. Participation in the NFIP is voluntary for local governments; however, program participation is strongly encouraged by FEMA as a first step for implementing and sustaining an effective hazard mitigation program. It is therefore used as part of this assessment as a key indicator for measuring local capability.

In order for a county or municipality to participate in the NFIP, they must adopt a local flood damage prevention ordinance that requires jurisdictions to follow established minimum building standards in the floodplain. These standards require that all new buildings and substantial improvements to existing buildings will be protected from damage by a 100-year flood event and that new development in the floodplain will not exacerbate existing flood problems or increase damage to other properties.

A key service provided by the NFIP is the mapping of identified flood hazard areas. Once completed, the Flood Insurance Rate Maps (FIRMs) are used to assess flood hazard risk, regulate construction practices, and set flood insurance rates. FIRMs are an important source of information to educate residents, government officials, and the private sector about the likelihood of flooding in their community.

Table 7.2 provides NFIP policy and claim information for each participating jurisdiction in Wake County.

[3] Participation in BCEGS is voluntary and may be declined by local governments if they do not wish to have their local building codes evaluated.

TABLE 7.2: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
WAKE COUNTY†	11/15/78	04/16/13	405	$108,769,300	62	$787,324
Apex	03/20/92	04/16/07	90	$25,797,600	0	$0
Cary	07/17/78	04/16/07	729	$211,433,100	83	$1,297,771
Fuquay-Varina	11/01/78	04/16/07	85	$20,597,500	1	$5,783
Garner	07/03/78	04/16/07	131	$30,599,600	18	$107,854
Holly Springs	12/23/94	04/16/07	74	$20,803,800	3	$32,312
Knightdale	08/01/78	04/16/07	35	$8,640,800	2	$17,361
Morrisville	11/01/78	04/16/07	92	$24,778,300	3	$66,219
Raleigh	08/15/78	04/16/07	1,988	$513,805,200	725	$18,503,795
Rolesville	07/31/01	04/16/07	9	$2,380,000	0	$0
Wake Forest	07/02/78	04/16/13	123	$35,436,900	0	$0
Wendell	06/01/78	04/16/07	13	$3,155,000	6	$77,232
Zebulon	07/03/78	04/16/13	18	$3,176,000	7	$183,092

†Includes unincorporated areas of county only
Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Community Rating System: An additional indicator of floodplain management capability is the active participation of local jurisdictions in the Community Rating System (CRS). The CRS is an incentive-based program that encourages counties and municipalities to undertake defined flood mitigation activities that go beyond the minimum requirements of the NFIP by adding extra local measures to provide protection from flooding. All of the 18 creditable CRS mitigation activities are assigned a range of point values. As points are accumulated and reach identified thresholds, communities can apply for an improved CRS class rating. Class ratings, which range from 10 to 1, are tied to flood insurance premium reductions as shown in **Table 7.3**. As class rating improves (the lower the number the better), the percent reduction in flood insurance premiums for NFIP policyholders in that community increases.

TABLE 7.3: CRS PREMIUM DISCOUNTS, BY CLASS

CRS Class	Premium Reduction
1	45%
2	40%
3	35%
4	30%
5	25%
6	20%
7	15%
8	10%
9	5%
10	0

Source: *FEMA*

Community participation in the CRS is voluntary. Any community that is in full compliance with the rules and regulations of the NFIP may apply to FEMA for a CRS classification better than class 10. The CRS application process has been greatly simplified over the past several years based on community comments. Changes were made with the intent to make the CRS more user-friendly and make extensive technical assistance available for communities who request it.

- The City of Raleigh (Class 7) is the only jurisdiction that currently participates in the CRS. Participation in the CRS program should be considered as a mitigation action by the County and other incorporated municipalities. The program would be most beneficial to the Town of Cary, Wake County, the Town of Garner, and the Town of Wake Forest, which have 729, 405, 131, and 123 NFIP policies, respectively.

Flood Damage Prevention Ordinance: A flood damage prevention ordinance establishes minimum building standards in the floodplain with the intent to minimize public and private losses due to flood conditions.

- All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. The County and all 12 incorporated municipalities also participate in the NFIP and they all have adopted flood damage prevention regulations.

Floodplain Management Plan: A floodplain management plan (or a flood mitigation plan) provides a framework for action regarding corrective and preventative measures to reduce flood-related impacts.

- Neither the County nor any of the incorporated municipalities have adopted floodplain management plans.

Open Space Management Plan*:* An open space management plan is designed to preserve, protect, and restore largely undeveloped lands in their natural state and to expand or connect areas in the public domain such as parks, greenways, and other outdoor recreation areas. In many instances, open space management practices are consistent with the goals of reducing hazard losses, such as the preservation of wetlands or other flood-prone areas in their natural state in perpetuity.

- The County and all 12 incorporated municipalities have adopted parks, recreation, greenways, and/or open space plan.

Stormwater Management Plan: A stormwater management plan is designed to address flooding associated with stormwater runoff. The stormwater management plan is typically focused on design and construction measures that are intended to reduce the impact of more frequently occurring minor urban flooding.

- The Town of Cary is the only jurisdiction that has adopted a stormwater master plan.
- Wake County and all 12 of the incorporated municipalities have adopted a stormwater management ordinance.

7.3.5 Administrative and Technical Capability

The ability of a local government to develop and implement mitigation projects, policies, and programs is directly tied to its ability to direct staff time and resources for that purpose. Administrative capability can be evaluated by determining how mitigation-related activities are assigned to local departments and if there are adequate personnel resources to complete these activities. The degree of intergovernmental coordination among departments will also affect administrative capability for the implementation and success of proposed mitigation activities.

Technical capability can generally be evaluated by assessing the level of knowledge and technical expertise of local government employees, such as personnel skilled in using Geographic Information Systems (GIS) to analyze and assess community hazard vulnerability. The Capability Assessment Survey was used to capture information on administrative and technical capability through the identification of available staff and personnel resources.

Table 7.4 provides a summary of the capability assessment results for Wake County with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in that jurisdiction with the specified knowledge or skill.

TABLE 7.4: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	WAKE COUNTY	Apex	Cary	Fuquay-Varina	Garner	Holly Springs	Knightdale	Morrisville	Raleigh	Rolesville	Wake Forest	Wendell	Zebulon
Planners with knowledge of land development / land management practices	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Engineers or professionals trained in construction practices related to buildings and/or infrastructure	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Planners or engineers with an understanding of natural and/or human-caused hazards	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Emergency Manager	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Floodplain Manager	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Land Surveyors													
Scientists familiar with the hazards of the community	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Staff with education or expertise to assess the community's vulnerability to hazards	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Personnel skilled in GIS and/or Hazus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Resource development staff or grant writers	✓						✓						

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

7.3.6 Fiscal Capability

The ability of a local government to take action is often closely associated with the amount of money available to implement policies and projects. This may take the form of outside grant funding awards or locally-based revenue and financing. The costs associated with mitigation policy and project implementation vary widely. In some cases, policies are tied primarily to staff time or administrative costs associated with the creation and monitoring of a given program. In other cases, direct expenses are linked to an actual project, such as the acquisition of flood-prone homes, which can require a substantial commitment from local, state, and federal funding sources.

The Capability Assessment Survey was used to capture information on the region's fiscal capability through the identification of locally available financial resources.

Table 7.5 provides a summary of the results for Wake County with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plans.

TABLE 7.5: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	WAKE COUNTY	Apex	Cary	Fuquay-Varina	Garner	Holly Springs	Knightdale	Morrisville	Raleigh	Rolesville	Wake Forest	Wendell	Zebulon
Capital Improvement Programming	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Community Development Block Grants (CDBG)	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓
Special Purpose Taxes (or taxing districts)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Gas / Electric Utility Fees		✓											
Water / Sewer Fees		✓											
Stormwater Utility Fees							✓						✓
Development Impact Fees		✓					✓						
General Obligation, Revenue, and/or Special Tax Bonds	✓	✓	✓		✓	✓	✓		✓				
Partnering Arrangements or Intergovernmental Agreements	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

7.3.7 Political Capability

One of the most difficult capabilities to evaluate involves the political will of a jurisdiction to enact meaningful policies and projects designed to reduce the impact of future hazard events. Hazard mitigation may not be a local priority or may conflict with or be seen as an impediment to other goals of the community, such as growth and economic development. Therefore, the local political climate must be considered in designing mitigation strategies as it could be the most difficult hurdle to overcome in accomplishing their adoption and implementation.

The Capability Assessment Survey was used to capture information on political capability of Wake County. Previous hazard mitigation plans were reviewed for general examples of local political capability, such as guiding development away from identified hazard areas, restricting public investments or capital improvements within hazard areas, or enforcing local development standards that go beyond minimum state or federal requirements (i.e., building codes, floodplain management, etc.).

- The previous local hazard mitigation plans identified existing ordinances that address natural hazards or are related to hazard mitigation such as flood damage prevention, watershed protection, soil erosion and sediment control, zoning, and subdivision.
- The citizens, property owners, business owners, and elected officials of Wake County are committed to improving the greater community through coordinated hazard mitigation planning efforts. The County has taken the lead in organizing and coordinating hazard mitigation efforts by inviting all 12 incorporated municipalities to participate in a planning process that has encouraged the sharing of common concerns and hazard issues.
- In the coming years, Wake County will continue to take a proactive role in planning for and encouraging mitigation of hazards that put citizens and property at risk. The elected Board of Commissioners remains committed to making the greater Wake County a safer community in which to live, work, and play, and as representatives of the citizens of Wake County, see hazard mitigation planning and implementation as a key component in helping to achieve that goal.

7.4 CONCLUSIONS ON LOCAL CAPABILITY

In order to form meaningful conclusions on the assessment of local capability, a quantitative scoring methodology was designed and applied to results of the Capability Assessment Survey. This methodology, further described in Appendix B, attempts to assess the overall level of capability of Wake County to implement hazard mitigation actions.

The overall capability to implement hazard mitigation actions varies among the participating jurisdictions. For planning and regulatory capability, the majority of the jurisdictions are in the high range. There is also some variation in the administrative and technical capability among the jurisdictions with larger jurisdictions generally having greater staff and technical resources. Almost all of jurisdictions are in the moderate range for fiscal capability.

Table 7.6 shows the results of the capability assessment using the designed scoring methodology. The capability score is based solely on the information found in existing hazard mitigation plans and readily available on the jurisdictions' government websites. According to the assessment, the average local capability score for all jurisdictions is 42.5, which falls into the high capability ranking.

TABLE 7.6: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
WAKE COUNTY	49	High
Apex	44	High
Cary	45	High

Fuquay-Varina	42	High
Garner	43	High
Holly Springs	40	High
Knightdale	44	High
Morrisville	41	High
Raleigh	46	High
Rolesville	38	Moderate
Wake Forest	40	High
Wendell	39	Moderate
Zebulon	40	High

As previously discussed, one of the reasons for conducting a Capability Assessment is to examine local capabilities to detect any existing gaps or weaknesses within ongoing government activities that could hinder proposed mitigation activities and possibly exacerbate community hazard vulnerability. These gaps or weaknesses have been identified for each jurisdiction in the tables found throughout this section. The participating jurisdictions used the Capability Assessment as part of the basis for the Mitigation Actions that are identified in Section 9; therefore, each jurisdiction addresses their ability to expand on and improve their existing capabilities through the identification of their Mitigation Actions.

7.4.1 Linking the Capability Assessment with the Risk Assessment and the Mitigation Strategy

The conclusions of the Risk Assessment and Capability Assessment serve as the foundation for the development of a meaningful hazard mitigation strategy. During the process of identifying specific mitigation actions to pursue, the Regional Work Groups considered not only each jurisdiction's level of hazard risk, but also their existing capability to minimize or eliminate that risk.

SECTION 8
MITIGATION STRATEGY

This section of the Plan provides the blueprint for the participating jurisdictions in Wake County to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Wake County Regional Work Groups and the Coordinating Committee and the findings and conclusions of the *Capability Assessment* and *Risk Assessment*. It consists of the following five subsections:

- 8.1 Introduction
- 8.2 Mitigation Goals
- 8.3 Identification and Analysis of Mitigation Techniques
- 8.4 Selection of Mitigation Techniques for Wake County
- 8.5 Plan Update Requirement

8.1 INTRODUCTION

The intent of the Mitigation Strategy is to provide the Wake County communities with the goals that will serve as guiding principles for future mitigation policy and project administration, along with an analysis of mitigation techniques available to meet those goals and reduce the impact of identified hazards. It is designed to be comprehensive, strategic, and functional in nature:

- In being *comprehensive*, the development of the strategy includes a thorough review of all hazards and identifies extensive mitigation measures intended to not only reduce the future impacts of high risk hazards, but also to help the region achieve compatible economic, environmental, and social goals.
- In being *strategic*, the development of the strategy ensures that all policies and projects proposed for implementation are consistent with pre-identified, long-term planning goals.
- In being *functional,* each proposed mitigation action is linked to established priorities and assigned to specific departments or individuals responsible for their implementation with target completion deadlines. When necessary, funding sources are identified that can be used to assist in project implementation.

The first step in designing the Mitigation Strategy includes the identification of mitigation goals. Mitigation goals represent broad statements that are achieved through the implementation of more specific mitigation actions. These actions include both hazard mitigation policies (such as the regulation of land in known hazard areas through a local ordinance) and hazard mitigation projects that seek to address specifically targeted hazard risks (such as the acquisition and relocation of a repetitive loss structure).

The second step involves the identification, consideration, and analysis of available mitigation measures to help achieve the identified mitigation goals. This is a long-term, continuous process sustained through the development and maintenance of this Plan. Alternative mitigation measures will continue to be considered as future mitigation opportunities are identified, as data and technology improve, as mitigation funding becomes available, and as this Plan is maintained over time.

The third and last step in designing the Mitigation Strategy is the selection and prioritization of specific mitigation actions for Wake County and its municipalities (provided separately in Section 9: *Mitigation Action Plan*). The county and each participating jurisdiction has its own Mitigation Action Plan (MAP) that reflects the needs and concerns of that jurisdiction. The MAP represents an unambiguous and functional plan for action and is considered to be the most essential outcome of the mitigation planning process.

The MAP includes a prioritized listing of proposed hazard mitigation actions (policies and projects) for Wake County and its municipalities to complete. Each action has accompanying information, such as those departments or individuals assigned responsibility for implementation, potential funding sources, and an estimated target date for completion. The MAP provides those departments or individuals responsible for implementing mitigation actions with a clear roadmap that also serves as an important tool for monitoring success or progress over time. The cohesive collection of actions listed in the MAP can also serve as an easily understood menu of mitigation policies and projects for those local decision makers who want to quickly review the recommendations and proposed actions of the Hazard Mitigation Plan.

In preparing each Mitigation Action Plan for Wake County, officials considered the overall hazard risk and capability to mitigate the effects of hazards as recorded through the risk and capability assessment process, in addition to meeting the adopted mitigation goals and unique needs of the community.

8.1.1 Mitigation Action Prioritization

Prioritization of the proposed mitigation actions was based on the following six factors:

- Effect on overall risk to life and property
- Ease of implementation
- Political and community support
- A general economic cost/benefit review[1]
- Funding availability
- Continued compliance with the NFIP

The work group point(s) of contact for each jurisdiction helped coordinate the prioritization process by reviewing each action and working with the lead agency/department responsible to determine a priority for each action using the six factors listed above.

[1] Only a general economic cost/benefit review was considered by the Regional Work Groups through the process of selecting and prioritizing mitigation actions. Mitigation actions with "high" priority were determined to be the most cost effective and most compatible with the participating jurisdictions' unique needs. Actions with a "moderate" priority were determined to be cost-effective and compatible with jurisdictional needs, but may be more challenging to complete administratively or fiscally than "high" priority actions. Actions with a "low" priority were determined to be important community needs, but the community likely identified several potential challenges in terms of implementation (e.g. lack of funding, technical obstacles). A more detailed cost/benefit analysis will be applied to particular projects prior to the application for or obligation of funding, as appropriate.

Using these criteria, actions were classified as high, moderate, or low priority by the participating jurisdiction officials.

8.2 MITIGATION GOALS

44 CFR Requirement
44 CFR Part 201.6(c)(3)(i): The mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

The primary goal of all local governments is to promote the public health, safety, and welfare of its citizens. In keeping with this standard, Wake County and the participating municipalities have developed seven goal statements for local hazard mitigation planning in the county. In developing these goals, the previous thirteen hazard mitigation plans were reviewed to determine areas of consistency. The project consultant reviewed the goals from each of the existing plans that were combined to form this multi-jurisdictional plan. Many of the goals were similar and county-wide goals were formulated based on commonalities found between the goals in each plan. These proposed county-wide goals and their corresponding goals or objectives from the previous plans are presented in **Table 8.1**.

The proposed regional goals were presented, reviewed, voted on, and accepted by the Regional Work Groups and presented to the Coordinating Committee for their final review. This process of combining goals from the previous plans served to highlight the planning process that had occurred in each jurisdiction prior to joining this multi-jurisdictional planning effort. Each goal, purposefully broad in nature, serves to establish parameters that were used in developing more mitigation actions. The Wake County Mitigation Goals are presented in **Table 8.2**. Consistent implementation of actions over time will ensure that community goals are achieved.

TABLE 8.1: PROPOSED MITIGATION GOALS

	Goal	Wake County	Apex	Cary	Fuquay-Varina	Garner	Holly Springs	Knightdale	Morrisville	Raleigh	Rolesville	Wake Forest	Wendell	Zebulon
#1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.	Goal 1	Goal 1	Goal 1	Goal 1	Goal 1	Goal 1		Goals 1, 3, 5	Goal 1	Goal 1		Goal 2	Goal 1
#2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions	Goal 2	Goal 2	Goal 2	Goal 2	Goal 2	Goal 2	Goal 7		Goal 2	Goal 2		Goal 8	Goal 2
#3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.	Goal 3	Goal 3	Goal 3	Goal 3	Goal 3	Goal 3		Goal 6	Goal 3	Goal 3			Goal 3
#4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.	Goal 4	Goal 4	Goal 4	Goal 4	Goal 4	Goal 4		Goal 2, 6	Goal 4	Goal 4			Goal 4
#5	Generally reduce the impact of all natural hazards	Goal 4	Goal 4	Goal 4	Goal 4	Goal 4	Goal 4	Goals 1,3, 4, 5, 6, 8		Goal 4	Goal 4	Goals 1, 2, 3, 4, 5, 6, 7, 8, 9, 10	Goals 1, 3, 4, 5, 6, 7	Goal 4
#6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural dis-aster.	Goal 4	Goal 4	Goal 4	Goal 4	Goal 4	Goal 4		Goal 4	Goal 4	Goal 4			Goal 4
#7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster	Goal 1	Goal 1	Goal 1	Goal 1	Goal 1	Goal 1		Goals 1, 3, 5	Goal 1	Goal 1	Goals 11, 12, 13, 14, 15, 16		Goal 1

TABLE 8.2: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

8.3 IDENTIFICATION AND ANALYSIS OF MITIGATION TECHNIQUES

44 CFR Requirement
44 CFR Part 201.6(c)(3)(ii): The mitigation strategy shall include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effect of each hazard, with particular emphasis on new and existing buildings and infrastructure.

In formulating the Mitigation Strategy for Wake County, a wide range of activities were considered in order to help achieve the established mitigation goals, in addition to addressing any specific hazard concerns. These activities were discussed during the Wake County Regional Work Group meetings. In general, all activities considered by the Regional Work Groups can be classified under one of the following six broad categories of mitigation techniques: Prevention, Property Protection, Natural Resource Protection, Structural Projects, Emergency Services, and Public Awareness and Education. These are discussed in detail below.

8.3.1 Prevention

Preventative activities are intended to keep hazard problems from getting worse, and are typically administered through government programs or regulatory actions that influence the way land is developed and buildings are built. They are particularly effective in reducing a community's future vulnerability, especially in areas where development has not occurred or capital improvements have not been substantial. Examples of preventative activities include:

- Planning and zoning
- Building codes
- Open space preservation
- Floodplain regulations

- Stormwater management regulations
- Drainage system maintenance
- Capital improvements programming
- Riverine / fault zone setbacks

Appendix E documents the full range of prevention activities that were considered by each jurisdiction for inclusion in the Mitigation Action Plan. Appendix E also lists the mitigation alternatives that were considered, but ultimately not selected for implementation. An explanation for why actions were not selected for implementation is provided.

8.3.2 Property Protection

Property protection measures involve the modification of existing buildings and structures to help them better withstand the forces of a hazard, or removal of the structures from hazardous locations. Examples include:

- Acquisition
- Relocation
- Building elevation
- Critical facilities protection
- Retrofitting (e.g., windproofing, floodproofing, seismic design techniques, etc.)
- Safe rooms, shutters, shatter-resistant glass
- Insurance

8.3.3 Natural Resource Protection

Natural resource protection activities reduce the impact of natural hazards by preserving or restoring natural areas and their protective functions. Such areas include floodplains, wetlands, steep slopes, and sand dunes. Parks, recreation, or conservation agencies and organizations often implement these protective measures. Examples include:

- Floodplain protection
- Watershed management
- Riparian buffers
- Forest and vegetation management (e.g., fire resistant landscaping, fuel breaks, etc.)
- Erosion and sediment control
- Wetland preservation and restoration
- Habitat preservation
- Slope stabilization

8.3.4 Structural Projects

Structural mitigation projects are intended to lessen the impact of a hazard by modifying the environmental natural progression of the hazard event through construction. They are usually designed by engineers and managed or maintained by public works staff. Examples include:

- Reservoirs
- Dams / levees / dikes / floodwalls
- Diversions / detention / retention
- Channel modification
- Storm sewers

8.3.5 Emergency Services

Although not typically considered a "mitigation" technique, emergency service measures do minimize the impact of a hazard event on people and property. These commonly are actions taken immediately prior to, during, or in response to a hazard event. Examples include:

- Warning systems
- Evacuation planning and management
- Emergency response training and exercises
- Sandbagging for flood protection
- Installing temporary shutters for wind protection

8.3.6 Public Education and Awareness

Public education and awareness activities are used to advise residents, elected officials, business owners, potential property buyers, and visitors about hazards, hazardous areas, and mitigation techniques they can use to protect themselves and their property. Examples of measures to educate and inform the public include:

- Outreach projects
- Speaker series / demonstration events
- Hazard map information
- Real estate disclosure
- Library materials
- School children educational programs
- Hazard expositions

8.4 SELECTION OF MITIGATION TECHNIQUES FOR WAKE COUNTY

In order to determine the most appropriate mitigation techniques for the communities in Wake County, the Regional Work Groups thoroughly reviewed and considered the findings of the *Capability*

Assessment and *Risk Assessment* to determine the best activities for their respective communities. Other considerations included the effect of each mitigation action on overall risk to life and property, its ease of implementation, its degree of political and community support, its general cost-effectiveness, and funding availability (if necessary).

8.5 PLAN UPDATE REQUIREMENT

In keeping with FEMA requirements for plan updates, the Mitigation Actions identified in the previous plans were evaluated to determine their 2014 implementation status. Updates on the implementation status of each action are provided. The mitigation actions provided in Section 9: *Mitigation Action Plan* include the mitigation actions from the previous plans as well as any new mitigation actions proposed through the 2014 planning process.

SECTION 9
MITIGATION ACTION PLAN

This section includes the listing of the mitigation actions proposed by the participating jurisdictions in Wake County. It consists of the following two subsections:

- 9.1 Overview
- 9.2 Mitigation Action Plans

44 CFR Requirement
44 CFR Part 201.6(c)(3)(iii): The mitigation strategy shall include an action plan describing how the actions identified in paragraph (c)(2)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction.

9.1 OVERVIEW

As described in the previous section, the Mitigation Action Plan, or MAP, provides a functional plan of action for each jurisdiction. It is designed to achieve the mitigation goals established in Section 8: *Mitigation Strategy* and will be maintained on a regular basis according to the plan maintenance procedures established in Section 10: *Plan Maintenance*.

Each proposed mitigation action has been identified as an effective measure (policy or project) to reduce hazard risk for Wake County. Each action is listed in the MAP in conjunction with background information such as hazard(s) addressed and relative priority. Other information provided in the MAP includes potential funding sources to implement the action should funding be required (not all proposed actions are contingent upon funding). Most importantly, implementation mechanisms are provided for each action, including the designation of a lead agency or department responsible for carrying the action out as well as a timeframe for its completion. These implementation mechanisms ensure that the Wake County Multi-Jurisdictional Hazard Mitigation Plan remains a functional document that can be monitored for progress over time. The proposed actions are not listed in priority order, though each has been assigned a priority level of "high," "moderate," or "low" as described below and in Section 8 (page 8.2).

The Mitigation Action Plan is organized by mitigation strategy category (Prevention, Property Protection, Natural Resource Protection, Structural Projects, Emergency Services, or Public Education and Awareness). The following are the key elements described in the Mitigation Action Plan:

- Hazard(s) Addressed—Hazard which the action addresses.
- Relative Priority—High, moderate, or low priority as assigned by the jurisdiction.
- Lead Agency/Department—Department responsible for undertaking the action.
- Potential Funding Sources—Local, State, or Federal sources of funds are noted here, where applicable.
- Implementation Schedule—Date by which the action the action should be completed. More information is provided when possible.

- Implementation Status (2014)—Indication of completion, progress, deferment, or no change since the previous plan. If the action is new, that will be noted here.

9.2 MITIGATION ACTION PLANS

The mitigation actions proposed by each of the participating jurisdictions are listed in 13 individual MAPs on the following pages. **Table 9.1** shows the location of each jurisdiction's MAP within this section as well as the number of mitigation actions proposed by each jurisdiction.

TABLE 9.1: INDIVIDUAL MAP LOCATIONS

Location	Page	Number of Mitigation Actions
Wake County	**9:3**	**47**
Apex	9:10	81
Cary	9:22	52
Fuquay-Varina	9:32	42
Garner	9:42	68
Holly Springs	9:55	64
Knightdale	9:77	39
Morrisville	9:85	18
Raleigh	9:91	44
Rolesville	9:103	35
Wake Forest	9:109	53
Wendell	9:118	37
Zebulon	9:124	36

Wake County Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Continue to prohibit the placement of any new residential or commercial structures or the introduction of fill in the floodway or floodway fringe.	Flood	High	Wake Planning and Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-2	Initiate hydrologic and hydraulic modeling of the stormwater system to provide a representation of watersheds and predict the water quantity response of streams and rivers to land use conditions and storm events.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-3	Apply 100-foot buffers to perennial streams in water supply watersheds, and study the possibility of increasing the protection of other watercourses and drainageways in Wake County.	Flood	Moderate	Wake Planning and Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-4	Apply 100-foot wide undisturbed stream buffers to the lower Swift Creek and study it for Little River watershed.	Flood	Moderate	Wake Planning and Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-5	Study the possibility of establishing either a stormwater utility or some other permanent dedicated funding source for stormwater and floodplain programs.	Flood, Drought, Riverine Erosion	High	N/A	Local	Deleted	Stormwater Management Task Force did not recommend this action. Board of Commissioners agreed.
P-6	Initiate NPDES Phase II Stormwater Program as required.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Deleted	Wake County does not have an MS4 System therefore a permit is not required.
P-7	Collaborate on NPDES Phase II minimum measures where local governments on a voluntary basis can request that Wake County provide staff and resources related to any and all functions required by Phase II stormwater rules.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-8	Create development regulations to encourage use of low impact development site planning principles to help control stormwater volume impacts.	Flood, Drought, Riverine Erosion, High Winds	Moderate	Wake Planning and Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-9	Study the possibility of revising the zoning ordinance to include impervious surface standards that help minimize impervious surface coverage in priority and healthy watersheds. Wake County opted for use of NRCS Curve Number approach, which is superior to impervious surface standards.	Flood, Drought, Riverine Erosion	Moderate	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-10	Implement post-construction stormwater runoff controls to address additional runoff volume from new development and issues related to flooding created from higher peak runoff rates.	Flood, Drought, Riverine Erosion	Moderate	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-11	Study the possibility of charging offset fees for development that exceeds set impervious surface ratios in priority watersheds.	Flood, Drought, Riverine Erosion	Moderate	N/A	Local	Deleted	Stormwater Management Task Force did not recommend this action. Board of Commissioners agreed.
P-12	Ensure sensitive site design through reviewing development plans, meeting with customers, and site inspections.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-13	Update the design manual for erosion control to include the newest, most effective site design technologies. Train staff on new techniques.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-14	Enhance erosion and sedimentation control programs, primarily through enhanced enforcement.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-15	Continue the stream monitoring program and seek to maximize efforts through coordination with other organizations.	Flood, Drought, Riverine Erosion	High	Wake Planning, Environmental Services, Municipalities, DENR-WQ, USGS, Ecosystems Enhancement Program	Local, Regional, State, Federal	Complete	This action was completed and will be removed from the next plan update.
P-16	Develop an Environmental Monitoring Program to evaluate current water quality conditions and monitor impacts of growth and development on the health and condition of water resources in the future.	Flood, Drought, Riverine Erosion	High	Wake Planning, Environmental Services, Municipalities, DENR-WQ, USGS, Ecosystems Enhancement Program	Local, Regional, State, Federal	2017-2019	In progress. Wake County is partnering with UNRBA to do ongoing stream monitoring in the Falls Lake watershed for the next 3-5 years.
P-17	Maintain an open space prioritization and acquisition program to ensure maximum success with limited funds.	Flood, Drought	High	Wake Land Acquisition Review Committee, Open Space and Parks Advisory Committee, Contractors, Municipalities, TJCOG, Trust for Public Lands, and Triangle Land Conservancy	Local, Regional, State, Federal	Complete	This action was completed and will be removed from the next plan update.
P-18	Partner with other governmental units and other interested parties to jointly identify and acquire 30,000 acres of open space lands.	Flood, Drought	High	Municipalities, State of NC, NC State University, Trust for Public Lands, and Triangle Land Conservancy	Local, Private, State, Federal	2019, with long term goal of Approx. 25-30 years	The County has purchased approximately 5,000 acres since the program's inception. It will take several decades as indicated to complete.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-19	Oversee completion of planned reclaimed water projects per the County's approved Community Improvement Program (CIP).	Drought	Moderate	Raleigh, Wake County	Local	2019-2021	Completed several reclaimed water projects in RTP and others directly related to County facilities. More projects are in the works going forward.
P-20	Perform demonstration projects for rainwater harvesting, nutrient reductions and runoff reductions and water conservation.	Drought	Moderate	Wake Soil and Water Conservation	Local	Complete	This action was completed and will be removed from the next plan update.
P-21	Develop enhanced information about water saving devices.	Drought	Moderate	Wake Soil and Water Conservation	Local	Complete	This action was completed and will be removed from the next plan update.
Property Protection							
PP-1	Continue to utilize Federal and State grants to address structures in floodplains: acquire and remove from the floodplain; or renovate, retrofit and/or elevate structures flooded after a President or State declared disaster.	Flood	Moderate	Wake Environmental Services, Finance-Risk Management, and General Services Administration	Federal, State, Local	Delete	The County is not actively seeking grants to address floodplain structures. The County will pursue it if an when the circumstances arise.
PP-2	Continue to provide service to inform and advise citizens of the actions they may take to improve drainage, halt erosion, and to relocate, renovate or retrofit structures being flooded.	Flood, Drought, Riverine Erosion	Moderate	Wake Environmental Services	Local, Private	Complete	This action was completed and will be removed from the next plan update.
Natural Resource Protection							
NRP-1	Continue local program to enforce Erosion and Sedimentation Control Standards. Cross train ES employees in other disciplines to improve efficiency.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
NRP-2	Employ a variety of regulated Best Management Practices (BMPs) in the Stormwater Program to reduce peak flows, provide groundwater recharge, etc. One-year and (sometimes) 10-year storm event design required. 100-year spillway capacity always required.	Flood, Drought, Riverine Erosion	Moderate	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-3	Consider regulations to regulate clear-cutting to help control erosion from construction sites.	Flood, Drought, Riverine Erosion	Moderate	Wake Environmental Services, Planning, and Community Services	Local	Complete	This action was completed and will be removed from the next plan update.
NRP-4	Maintain the County's cluster and open space subdivision regulations and recreation land dedication ordinance to enhance conservation efforts.	All	High	Wake Environmental Services, Planning, and Community Services	Local	Complete	This action was completed and will be removed from the next plan update.
NRP-5	Study the possibility of developing a conservation subdivision, or open space subdivision, ordinance to help preserve significant natural features.	All	Moderate	Wake Environmental Services, Planning, and Community Services	Local	Complete	This action was completed and will be removed from the next plan update.
Structural Projects							
SP-1	Inspection and maintenance of Crabtree Creek flood control structures.	Flood	High	Wake General Services Administration	Local	Complete	This action was completed and will be removed from the next plan update.
SP-2	Channel Maintenance - Possibility of private property owner assistance program to be investigated as part of stormwater utility feasibility study.	Flood, Riverine Erosion	High	Wake Environmental Services	Local	Delete	Stormwater Management Task Force did not recommend this action. Board of Commissioners agreed.
SP-3	Pursue stream restoration projects and will look for ways to expand the program through partnerships with various entities.	Flood, Riverine Erosion	High	Wake Environmental Services , Community Services, DENR-WQ Ecosystems Enhancement Program, USACE	Local, Regional, State, Federal	Complete	This action was completed and will be removed from the next plan update.
Emergency Services							
ES-1	Identify priority County facilities and provide access to one main entrance. Restore life safety and building systems as needed.	All	High	Wake General Services Administration	Local, FEMA	Complete	This action was completed and will be removed from the next plan update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-2	Develop a Business Continuity Plan, the primary document housing all disaster related plans and procedures.	All	High	Wake Emergency Management	Local	Complete	This action was completed and will be removed from the next plan update.
ES-3	Oversee completion of planned equipment replacements/upgrades for 800 MGHZ emergency communications systems, EMS facilities, and fire/rescue facilities per the approved capital improvement program.	All	High	Wake Facilities Design and Construction	Local	December 2018	In progress. The 800 MGHZ replacements are underway and scheduled for completion in 2018.
Public Education and Awareness							
PEA-1	Provide monitoring and enforcement of Wake County flood hazard regulations.	Flood	Moderate	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-2	Provide flood zone information through call-in or e-mail program to any inquirer. County requires showing flood zone information on all plats recorded in County planning jurisdiction.	Flood	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-3	Maintain a web site to answer citizen questions about flood hazards, flood safety, availability of flood insurance, stormwater regulations, and other information.	Flood	Moderate	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-4	Partner with Raleigh to use the "Communicator" application that will use GIS to develop automated call lists to warn residents of impending floods	Flood	High	Emergency Management & GIS	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-5	Maintain Environmental Network Call Center. Citizens may report flooding problems, pollution issues, erosion problems, infrastructure damage, littering, etc.	All	Moderate	Wake Environmental Services	Local	2019	This call center is in place, but a review and update of the system will be likely in the coming years.
PEA-6	Adopt updates to floodplain maps. Staff will review maps and identify all structures in floodplains and notify property owners of the risks and availability of flood insurance. List forwarded to Emergency Management.	Flood	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-7	Maintain flood elevation certificates.	Flood	Moderate	Wake Environmental Services and Community Services	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-8	Update flood hazard maps to reflect new subdivisions, changes in corporate limits, and any new DFIRM data.	Flood	Moderate	Wake GIS	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-9	Continue to use the State's Residential Property Disclosure Statement that includes check off on whether or not the property being offered for sale is within a Federally-designated floodplain.	Flood	Moderate	State of NC, Realtors	State	Delete	The county is not responsible for this action, but the state and realtors are ensuring that this is taking place.
PEA-10	Continue to make flood protection educational materials available.	Flood	Moderate	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-11	Provide environmental education classes for development community and residents using Clearwater Contractor Education Program as model.	Flood	High	Wake Environmental Services, Community Services, and Municipalities	Local, State	Delete	Insufficient staff resources to accomplish this action.
PEA-12	Consider a countywide stormwater call center to improve response time to customers, provide an educational component, and allow stormwater staff to devote more time to solving problems	Flood	High	Wake Environmental Services, Community Services, and Municipalities	Local, State	Delete	Insufficient staff resources to accomplish this action.
PEA-13	Develop common public education materials and programs to inform the public on stormwater issues and convince them to change their behaviors accordingly.	Flood, Drought, Riverine Erosion	Moderate	Wake County Soil and Water Conservation	Local, State	Complete	This action was completed and will be removed from the next plan update.

Town of Apex Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Adoption of the Comprehensive Land Use Plan that will provide a 20 year plan for the town and include goals and policies for public safety and hazard mitigation.	All	High	Apex Planning	Local	Completed	Completed 2004. In addition, a Western Area Plan was approved in 2008. The Land Use Map was updated in 2013. This action will be removed from the next update as a capability.
P-2	Land Use Plan (long-range): As town grows towards Jordan Lake, lower density and cluster development. The HMP was reviewed with considerations made for density and cluster development while drafting the plan updates in 2004, 2008, and 2013.	All	Moderate	Apex Planning	Local	Completed	Completed 2004, 2008, and 2013. In 2013, the Land Use Map 2030 increased the density of some areas adjacent to Army Corp Land. (Apex is determining how many acres increased). In addition, the Land Use Map removed land south of Hwy 1 (Apex GIS is determining how many acres). This action will be removed from the next update as a capability.
P-3	UDO: Continue to provide stream and creek buffers, and floodplain and wetland protection. HMP considerations incorporated into the UDO process.	Flood	High	Apex Planning	Local	Completed	UDO continues to provide stream and creek buffers, floodplain, and wetland protection. This action will be removed from the next update as a capability.
P-4	UDO: Resource Conservation Areas (RCA) – Continue to protect floodplains, streams, and creeks. HMP considerations incorporated into the UDO process.	Flood	High	Apex Planning	Local	Completed	UDO RCA continues to protect floodplains, streams, and creeks. This action will be removed from the next update as a capability.
P-5	UDO: Subdivision Standards – Continue to provide protection for residential areas by not allowing residential lots in the floodplain. HMP considerations incorporated into the UDO process.	Flood	High	Apex Planning	Local	Completed	UDO (adopted in 2000) does not allow residential lots within floodplain. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-6	Building Code – Ensure buildings are minimum 2' above base flood elevation. HMP considerations incorporated into the UDO process.	Flood	High	Apex Construction Management	Local	Completed	Building Code, ensure buildings are minimum 2 feet above base flood elevation. This action will be removed from the next update as a capability.
P-7	UDO: Flood Damage Prevention Overlay District – Continue to restrict and prohibit uses which are dangerous to health, safety, and property. Uses vulnerable to floods are protected. HMP considerations incorporated into the UDO process. HMP considerations incorporated into the UDO process.	Flood	High	Apex Planning, Apex Construction Management (Floodplain Manager)	Local	Completed	UDO Section 6. Flood Damage Prevention Overlay District. This action will be removed from the next update as a capability.
P-8	UDO: Flood Damage Prevention – Ensure control is provided for filling, grading and dredging within floodplains by working with necessary State and Federal Agencies. HMP considerations incorporated into the UDO process.	Flood	Moderate	Apex Planning, Apex Construction Management	Local	Completed	Flood Damage Prevention Ordinance. This action will be removed from the next update as a capability.
P-9	UDO: Flood Damage Prevention – prevent or regulate construction of flood barriers. HMP considerations incorporated into the UDO process.	Flood	Moderate	Apex Construction Management	Local	Completed	Flood Damage Prevention Ordinance. This action will be removed from the next update as a capability.
P-10	UDO: Watershed Protection Overlay District – Ensure riparian buffers are provided for perennial and intermittent streams, lakes, and ponds. HMP considerations incorporated into the UDO process.	Flood	High	Apex Planning, Apex Public Works and Utilities	Local	Completed	Watershed Protection Overlay District. This action will be removed from the next update as a capability.
P-11	UDO 7.2.1 - Streets – Ensure road standards to be maintained in disaster preparation for possible use as evacuation routes. Amendments to the Transportation Plan included street standards and interconnectivity for possible use in routing. HMP considerations incorporated into the UDO process.	All	Moderate	Apex Planning	Local	Completed	UDO and Transportation Plan. Road standards and interconnectivity. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-12	Provide adequate water supply through storage and interconnection with other public water systems.	Drought	Moderate	Apex Public Works and Utilities	Local	Completed	The town works with surrounding municipalities and the county to ensure an adequate water supply. This action will be removed from the next update as a capability.
P-13	Provide adequate electric utility service through tree trimming contracts, the use of six circuits, and the construction of a new electrical substation.	All	Moderate	Apex Public Works and Utilities	Local	Completed	Public Works has its own Tree Trimming crew with Arborists. This action will be removed from the next update as a capability.
P-14	Provide backup power for all critical public facilities (wastewater treatment plant, sewer pump stations, Public Works and Utilities building, and other critical public buildings).	All	Moderate	Apex Public Works and Utilities	Local	Completed	Critical public buildings have backup power. This action will be removed from the next update as a capability.
P-15	Maintain major town transportation routes through snow and ice removal contracts and equipment.	Severe Winter Storms	Moderate	Apex Public Works and Utilities	Local	Completed	Public Works included a salt/sand container in 2012. This action will be removed from the next update as a capability.
P-16	Require Engineered Storm Water Control Structures.	Flood	Moderate	Apex Public Works and Utilities	Local	Completed	The town continues to evaluate locations for stormwater control structures and has installed some of these structures in the past. This action will be removed from the next update as a capability.
P-17	Back-up information pertaining to Town government in case of an emergency.	All	Moderate	Apex Information Technology	Local	Completed	Town of Apex on a regular basis backs-up information pertaining to Town government in case of an emergency. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-18	Apex Transportation Plan – Continue to address disaster preparedness (evacuation) through road interconnectivity, paved roads, and widening of roads.	All	Moderate	Apex Planning	Local	Completed	Amendments to the Transportation Plan included street standards and interconnectivity for possible use in routing. This action will be removed from the next update as a capability.
P-19	Review and update as necessary UDO Flood Damage Prevention Overlay District regulations to increase protection from flood hazard events.	Flood	Moderate	Apex Planning	Local	Completed	The UDO Flood Damage Prevention Overlay District needs to be reviewed and updated regularly. This action will be removed from the next update as a capability.
P-20	Develop adverse Weather Plan Map for Public Works Work Crew.	All	High	Apex Construction Management	Local	Completed	The Adverse Weather Plan Map has been developed. This action will be removed from the next update as a capability.
P-21	Adopt FEMA's new FIRM.	Flood	High	Apex Planning	Federal	Deleted	Deleted. Item is redundant and P-26 suffices.
P-22	Adopted additional Title 44 Federal Regulations to the Unified Development Ordinance.	Flood	High	Apex Planning	Federal	Completed	Completed 2006. Adopted additional Title 44 Federal Regulations to the UDO. This action will be removed from the next update as a capability.
P-23	Adopted additional Chapter 143 NC General Statutes regarding floodway regulation.	Flood	High	Apex Construction Management	State	Completed	Completed. Adopted additional Chapter 143 NC General Statutes to the UDO. This action will be removed from the next update as a capability.
P-24	Implemented new Floodplain Development Permit.	Flood	High	Apex Construction Management	Local	Completed	Completed. A new floodplain development permit has been implemented for use in the town. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-25	Maintain Continuing Education Training for maintenance of Floodplain Management Certificate (16 hours).	Flood	High	Apex Construction Management	Local	Completed	Completed every 2 years by Floodplain Manager. This action will be removed from the next update as a capability.
P-26	FEMA Flood Map updates and Flood Plain Manager Certification.	Flood	High	Apex Construction Management	Local	Deleted	Delete. Similar to P-21 and P-25
P-27	Develop FEMA Debris Management Plan.	All	High	Apex Public Works and Utilities	Local	Completed	The Debris Management Plan has been developed so this action is completed. This action will be removed from the next update as a capability.
P-28	Allow fill but no structures within the Floodplain.	Flood	High	Apex Planning, Apex Construction Management (Floodplain Manager)	Local	Completed	Revised April 2012. Changed from “proposed no construction tilling within the Floodplain.” This action will be removed from the next update as a capability.
P-29	Created new Transportation Planner position.	All	High	Apex Planning	Local	Completed	Completed 2006. Apex plans on retaining a Transportation Planner. This action will be removed from the next update as a capability.
P-30	Coordinate Transportation Planning with CAMPO.	All	High	Apex Planning	Local	Completed	The town coordinates regularly with CAMPO on Transportation Planning. This action will be removed from the next update as a capability.
P-31	Revise and update regulatory floodplain maps.	Flood	Moderate	Apex Construction Management (Floodplain Manager)	Local	2017	New action.
P-32	Designate a local floodplain manager and/or CRS coordinator who achieves CFM certification.	Flood	Moderate	Apex Construction Management (Floodplain Manager)	Local	2015	New action.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-33	Develop an environmental committee that meets regularly to discuss issues and recommend projects.	Flood, Drought, Erosion, Wildfire, Landslide	Moderate	Apex Public Works (Environmental Program Director)	Local	2015	New action.
P-34	Form a citizen plan implementation steering committee to monitor progress on local mitigation actions. Include a mix of representatives from neighborhoods, local businesses, and local government.	Flood	Moderate	Apex Public Works (Environmental Program Director)	Local	5 years	New action.
P-35	Encourage the use of Low Impact Development techniques.	Flood	Low	Apex Public Works (Environmental Program Director)	Local	5 years	New action.
P-36	Encourage the use of porous pavement, vegetative buffers, and islands in large parking areas.	Flood	Low	Apex Public Works (Environmental Program Director)	Local	5 years	New action.
P-37	Encourage the use of permeable driveways and surfaces to reduce runoff and promote groundwater recharge.	Drought, Flood	Low	Apex Public Works (Environmental Program Director)	Local	5 years	New action.
P-38	Use impact fees to help fund public projects to mitigate impacts of land development.	Flood	Moderate	Apex Public Works (Environmental Program Director)	Local	5 years	New action.
P-39	UDO update: incorporate proper specials selection, planting, and maintenance practices into landscape ordinance.	All	Moderate	Apex Planning	Local	2017	New action.
P-40	Obtain local data including tax parcels, building footprints, critical facility locations, and other information for use in risk analysis.	All	Moderate	Apex GIS, Apex Construction Management	Local	2015	New action.
P-41	Incorporate a GIS system/management plan for tracking permitting and land use patterns.	All	Moderate	Apex GIS	Local	2018	New action.
Property Protection							
PP-1							

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Natural Resource Protection							
NRP-1	UDO 6.1.12 – Continue to require engineered stormwater controls including stream and wetland protection. HMP considerations incorporated into the UDO process.	Flood	Moderate	Apex Planning, Apex Public Works	Local	Completed	UDO continues to require engineered stormwater controls. This action will be removed from the next update as a capability.
NRP-2	UDO 6.2 - Flood Damage Prevention Overlay District - continue to prohibit any development in floodway to protect floodplains and wetlands. HMP considerations incorporated into the UDO process.	Flood	Moderate	Apex Planning, Apex Construction Management	Local	Completed	UDO continues to prohibit any development in the floodway. This action will be removed from the next update as a capability.
NRP-3	Phase 1 C Beaver Creek Greenway – Whitehall to Jaycee.	All	High	Apex Parks and Recreation	Local	Completed	Phase 1 C Beaver Creek Greenway was completed in 2009. This action will be removed from the next update as a capability.
NRP-4	Phase II Haddon Hall Greenway.	All	High	Apex Parks and Recreation	Local	Completed	Phase II Haddon Hall Greenway was completed in 2009. This action will be removed from the next update as a capability.
NRP-5	Phase I Apex Nature Park.	All	High	Apex Parks and Recreation	Local	Completed	Phase I Apex Nature Park was completed in 2011. This action will be removed from the next update as a capability.
NRP-6	Phase II Nature Park.	All	High	Apex Parks and Recreation	Local	Completed	Phase II Nature Park was completed in 2012. This action will be removed from the next update as a capability.
NRP-7	Extend Beaver Creek Greenway (Kelly Road to Nature Park).	All	High	Apex Parks and Recreation	Local	Completed	Completed and Revised. Green infrastructure program to link, manage, and expand existing parks, preserves, and greenways. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-8	Water Shortage Response Plan.	All	High	Apex Public Works and Utilities	Local	Completed	The Water Shortage Response Plan is in place and active. This action will be removed from the next update as a capability.
NRP-9	Adoption of NC Division of Water Quality Best Management Practices Manual for NPDES Phase II Community.	All	High	Apex Public Works and Utilities	Local, State	Completed	Completed. The town has adopted NC DWQ Best Management Practices for Phase II Community. This action will be removed from the next update as a capability.
NRP-10	Adopt erosion and sedimentation control regulations for construction and farming.	Flood, Erosion	Moderate	Apex Construction Management (Floodplain Manager)	Local	2019	New action.
NRP-11	Use stream restoration to ensure adequate drainage and diversion of stormwater.	Flood	Moderate	Apex Public Works (Environmental Program Director)	Local	2019	New action.
NRP-12	Middle Creek Greenway (Miramonte to Holly Springs).	All	Moderate	Apex Parks and Recreation	Local	2019	New action. Green infrastructure program to link, manage, and expand existing parks, preserves, and greenways.
NRP-13	White Oak Creek Greenway.	All	Moderate	Apex Parks and Recreation	Local	2020	New action. Green infrastructure program to link, manage, and expand existing parks, preserves, and greenways.
Structural Projects							
SP-1							
Emergency Services							
ES-1	Ongoing provision of emergency assistance as needed.	All	High	Apex Police, Apex EMS, Apex Fire	Local	Completed	Emergency assistance is provided for as needed. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-2	Emergency Operations Command Post Center – established when natural hazard imminent. If needed, Center coordinates evacuations, sheltering, staging for equipment, manpower, and needed supplies. Equipment includes internet access, telephone, wireless communications, radio and backup supplied by emergency batteries and/or generators.	All	High	Apex Fire, Apex EMS, Apex Police	Local	Completed	Emergency Operations Center has been established in the past when events occur. This will continue to occur in the future. This action will be removed from the next update as a capability.
ES-3	Ensure hazard warning methods include television, radio, internet and, if needed, emergency vehicles loud speaker systems.	All	Moderate	Apex Town Manager's Office	Local	Completed	Hazard warning methods are varied and include many different types of warning systems. These systems are in place. This action will be removed from the next update as a capability.
ES-4	Maintain open lines of communication between all branches of emergency response personnel.	All	Moderate	Apex Fire, Apex EMS	Local	Completed	Open lines of communication between the emergency response personnel are in place. This action will be removed from the next update as a capability.
ES-5	Prepare for emergency situations – weather station, local weather warning system, and emergency management.	All	Moderate	Apex Fire	Local	Completed	Preparations for emergency situations are undertaken prior to an emergency utilizing a number of sources such as weather stations and emergency management. This action will be removed from the next update as a capability.
ES-6	Standard Operating Guidelines – collection of procedures to be followed during emergencies.	All	High	Apex Fire	Local	Completed	Updated Standard Operating Guidelines are in place that explain how the town should act during an emergency situation. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-7	Maintain contact information for local businesses in case of an emergency.	All	High	Apex Fire	Local	Completed	A list of local businesses has been developed. This action will be removed from the next update as a capability.
ES-8	Health and safety maintenance – provide assistance with security and post storm clean-up.	All	High	Apex Police	Local	Completed	During an event, assistance with security and post storm cleanup is provided by the police department. This action will be removed from the next update.
ES-9	Post disaster response – building inspections.	All	Moderate	Apex Construction Management	Local	Completed	After a disaster event, building inspections are carried out to assess damage. This action will be removed from the next update.
ES-10	Town of Apex Fire Department will merge with Apex EMS (formerly private).	All	High	Apex Fire, Apex EMS	Local	Deleted	Deleted. Not completed due to budget concern.
ES-11	Chemical Fire Action Report available on CD.	Fire	High	Apex Fire	Local	Completed	The Chemical Fire Action Report was completed in 2006. This action will be removed from the next update as a capability.
ES-12	Construct Fire Station #4.	Fire	High	Apex Fire	Local	Completed	Fire Station #4 was completed in 2009. This action will be removed from the next update as a capability.
ES-13	Construct Fire Stations #5 and #6.	Fire	Moderate	Apex Fire	Local	2017	Locations for #5 and #6 are still pending so this action is still a work in progress.
ES-14	State Fire Marshall Office Grant – providing smoke detectors to low-income residents.	Fire	High	Apex Fire	State	Completed	The grant has been received and smoke detectors are being distributed. This action will be removed from the next update as a capability.
ES-15	Acquire additional 4 ambulances.	All	High	Apex EMS	Local	Deleted	Not completed due to budget and not merging with Apex EMS.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-16	Community Emergency Response Team (CERT) training available through Fire Department.	All	Moderate	Apex Fire	Local	Completed	CERT training remains available through the Fire Department. This action will be removed from the next update as a capability.
Public Education and Awareness							
PEA-1	Town website - public access, emergency information and contact numbers, link to hurricane and Harris nuclear evacuation route maps and safety information. Revise the Emergency Information Page. Add Ready Wake link.	All	Moderate	Apex Information Public Officer	Local	2015	The town website has been updated with information for public use, but that information should be revised.
PEA-2	Hazard Disclosure – Geographic information systems (GIS) map maintained to increase public awareness of known hazard locations.	Flood	Moderate	Apex Planning	Local	Completed	A GIS map and database for the public is maintained. This action will be removed from the next update as a capability.
PEA-3	Planned park land purchase – nature park to include trails and environmental education center.	Flood	High	Apex Parks and Recreation	Local Wake County	Completed	Completed. Nature Park in operation. This action will be removed from the next update as a capability.
PEA-4	Public Library – Maintain and update hazard information accessible to the public.	All	Moderate	Apex Planning	Local	Within 30 days after HMP update is adopted by Town Council	Through 2014, the town has maintained up to date information on hazards in its public library and will update public library with information on hazards after the plan has been approved and adopted.
PEA-5	Continue to provide flood maps for public use with staff continuing to be available for public assistance.	Flood	High	Apex Planning, Apex Construction Management (Floodplain Manager)	Local	Completed	A flood map for the public is maintained. This action will be removed from the next update as a capability.
PEA-6	Bi-annual update of the Town's website for broken links.	All	Moderate	Apex Information Public Officer	Local	Completed	The town reviews its website for broken links on a bi-annual basis. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-7	National Night Out – Hurricane/Disaster Awareness Open House.	Hurricane	High	Apex Planning, Apex Fire, Apex EMS	Local	Deleted	Deleted. Incorporated under action PEA-17.
PEA-8	Include FEMA flood map link on the Town Website on the Engineering page.	Flood	High	Apex Construction Management (Information Public Officer)	Local	2015	New action.
PEA-9	Town website and utility billing announcing National Preparedness Month (September) reminding citizens to have a plan and be prepared.	All	Moderate	Apex Information Public Officer	Local	2015	New action.
PEA-10	Include Environment Education Station and classroom at Nature Park.	All	Moderate	Apex Parks and Recreation	Local	2019	New action.
PEA-11	Post warning signage at local parks for lightning.	Lightning	Moderate	Apex Parks and Recreation	Local	2019	New action.

Town of Cary Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Town stormwater staff will continue to maintain current level of control of development in flood hazard areas with ordinance amendments as necessary.	Flood	High	Cary Water Resources	Local	Completed	Amend LDO as needed to maintain or exceed mandated requirements. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-2	Town will continue to participate in the NFIP thereby keeping current with all applicable NFIP flood hazard regulations.	Flood	High	Cary Water Resources	Local	Completed	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-3	Town's Comprehensive Plan- The Town has an existing comprehensive plan which includes land use, parks and recreation, open space, transportation, utilities, and environment.	All	High	Cary Planning	Local	Completed 1996 Regular updates on-going	Town Is in process of preparing new Community Plan incorporating all elements of existing Comp Plan. Adoption expected in 2015.
P-4	Land Use Plan An existing tool which guides future development based on available services and existing site features/resources to ensure that future development is meeting the overall vision of the Town while ensuring the safety of the citizens.	All	High	Cary Planning	Local	Adoption 1996 Regular updates through area plans	Town Is in process of preparing new Community Plan incorporating all elements of existing Comp Plan. Adoption expected in 2015.
P-5	Southwest Area Plan – Lower densities of development are planned as the Town grows toward Jordan Lake.	All	High	Cary Planning	Local	Adoption in 2004 Perpetual implementation through standards in LDO	Continued implementation through review and approval of development plans. Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-6	Northwest Area Plan - Plan requires 200 foot buffers adjacent to the four major streams in the area west of NC 55 and north of Morrisville Parkway heading westward to Jordan Lake.	All	High	Cary Planning	Local	Adoption in 2003 Perpetual implementation through standards in LDO	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-7	Open Space Preservation – Existing Open Space Plan identifies and evaluates various land and open space resources throughout the ETJ and Urban Services Areas. The plan is used by Town staff to identify properties to be protected from development.	Flood	High	Cary Planning	Local	Adoption in 2002 Perpetual implementation through standards in LDO	Town Is in process of preparing new Community Plan incorporating all elements of existing Comp Plan. Adoption expected in 2015.
P-8	Building Code – In accordance with North Carolina General Statute, Chapter 160A, Article 19 the Town of Cary administers a Building Inspections program to uphold/enforce the 2009 NC State Building Code. These regulations provide guidance on design criteria for flood, roof snow load, wind design, wind speed, seismic design, eeathering, frost line depth, termite infestation and decay.	All	High	Cary Inspections and Permits	Local	Completed	Continued implementation through review and approval of permits. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-9	Land Development Ordinance- The Town has an existing LDO which regulates development to ensure public health, safety and welfare of Cary residents and businesses.	All	High	Cary Planning	Local	Completed	Continued implementation through review and approval of development plans, permits and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-10	Provide adequate water supply through storage and interconnection with other public water systems.	Drought	High	Cary Public Works, Utilities and Water Resources	Local	Completed	See also ES-13. Drought or other conditions have not warranted activation of Response Plan. However Plan is in place if needed. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-11	Transportation Plan - Addresses disaster preparedness (evacuation) through road interconnectivity, pavement practices, signal preemption, etc.	All	High	Cary Facilities Design & Transportation Services, and Planning	Local	Completed implementation through standards in LDO	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-12	Floodplain Development Regulations – Ordinance restricts and/or prohibits uses which are dangerous to health, safety, and property due to water or erosion hazards which result in damaging increases in erosion or in flood heights or velocities.	Flood	High	Cary Water Resources	Local	Completed implementation through standards in LDO	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-13	Amend Town of Cary Land Development Ordinance and Zoning map as needed to begin implementation of the Chatham-Cary Joint Land Use Plan (if adopted).	All	High	Cary Planning	Local	Completed	Completed. Joint Plan adopted June 28, 2012.
P-14	Amend Code of Ordinances to restrict use of combustible landscape materials.	Wildfire	High	Cary Fire	Local	Completed	Deleted. Was previously completed in 2010.
P-15	If grant application is approved by FEMA, the Town will conduct a detailed study to determine the risk level of each residential structure in the identified floodplain areas and take actions to reduce the risk to those properties.	Flood	High	Cary Water Resources	Federal Grant	2018	Not implemented. Town applied for grant and was turned down. The town would like to implement if funding becomes available.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Natural Resource Protection							
NRP-1	Local Sedimentation and Erosion Control program approved by the NCDENR. Three staff members dedicated to this program.	Flood	High	Cary Water Resources	Local	Completed	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
NRP-2	Town requires installation of Best Management Practices to help with water quality and natural resource protection.	Flood	High	Cary Water Resources	Local	Completed	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
NRP-3	Forestry Practices - Existing program which requires a timbering plan within Town limits and ETJ.	Flood	Moderate	Cary Water Resources	Local	Completed	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
NRP-4	Wetlands Protection - Existing riparian, open space, and flood damage prevention ordinances restrict development along streams and in the floodplain thus restricting development in much of the Town's wetland areas.	Flood	Moderate	Cary Water Resources	Local	Completed, implementation through standards in LDO	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
NRP-5	Prepare a Stormwater Master Plan to help guide future stormwater management policies and procedures.	Flood	High	Cary Water Resources	Local	Completed	Completed. Adopted July 2013.
Structural Projects							
SP-1	Replace culverts on Holloway Street.	Flood	High	Cary Water Resources	Local	Completed	Completed. Project completed in early 2014.
SP-2	Replace culverts on Willow Street.	Flood	High	Cary Water Resources	Local	2015	In progress. Design in process. Schedule affected by workload.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
SP-3	Replace culverts on Woodland Drive.	Flood	High	Cary Water Resources	Local	2014	In progress. Bidding in process. Construction to begin July 2014. Schedule affected by workload.
SP-4	Replace culverts on Summer Lakes Drive	Flood	High	Cary Water Resources	Local	2015	New action. Design in process.
SP-5	Replace culverts on Kilarney Drive	Flood	High	Cary Water Resources	Local	2015	New action. Design in process.
SP-6	Replace culverts on Yubinaranda Circle	Flood	High	Cary Water Resources	Local	2015	New action. Design in process.
Emergency Services							
ES-1	Provide and enhance technical rescue capabilities throughout the Town.	All	High	Cary Fire	Local	2016	Funding approved for additional boat and structural collapse equipment
ES-2	Provide after-action report of emergency response to severe weather events in order to improve planning for future disasters.	All	High	Cary Fire, Water Resources, and Facilities Design & Transportation Services	Local	Perpetual- Post Event	A report is prepared and a debriefing meeting conducted after each significant event. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-3	Maintain a standard operating guideline to direct operational planning prior to anticipated weather emergencies.	All	High	Cary Fire	Local	Deleted	Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-4	Establish a relationship/partnership with the Renaissance Computing Institute (RENCI) to create a web-based tool capable of providing real-time flood data to emergency managers and historic data for future emergency response planning.	All	Low	Cary Fire and Technology Services	Local	2020	No action at this time. Low Priority due to limited staff and budget resources and limited applicability and risk. The town will attempt to develop in the coming years.
ES-5	Provide urban search and rescue services for structural collapse and similar emergencies.	All	High	Cary Fire	Local, State	Deleted	Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-6	Utilize visual warning barricades for vehicular and pedestrian traffic to block properties, roadways, etc. for the safety of the general public.	All	Moderate	Cary Public Works	Local	Completed	Public works staff utilized barricades whenever needed, typically a few times per year following heavy rain events, to ensure public safety. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-7	Continue to conduct disaster tabletop exercise program.	All	Low	Cary Fire, Public Works, and Utilities	Local	Completed	Mock hurricane and snowstorm events are conducted annually to prepare for hurricane season and winter. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-8	Critical Security Post Coverage – certain fixed sites identified for coverage during disasters – water treatment, municipal complex, wastewater treatment, etc. Vulnerable businesses and offices identified and contacted in event of rising waters.	All	Low	Cary Police	Local	Completed l	Businesses contacted during approximately 8-10 severe weather events during plan period. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-9	Emergency response plans are designed for officers to be assigned for security purposes until owners can take over the responsibility of securing premises.	All	Low	Cary Police	Local	Completed	Properties secured during approximately 5-7 severe weather events during plan period. Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-10	Counseling – Police psychologist and Critical Incident Stress Debriefing Team training to provide debriefing sessions for personnel.	All	Low	Cary Police	Local	Completed	Post-indent counseling and training provided for approximately 10 employees after critical incidents. Support continued with through post-traumatic support group. Incident represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-11	Utilize Water Emergency Response Plan in accordance with EPA mandate with wastewater emergency plan developed voluntarily.	All	High	Cary Utilities	Local	Completed	All required permits maintained with strong record of compliance Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-12	Maintain emergency electrical generators at all critical public utilities facilities.	All	High	Cary Utilities	Local	Completed	50 or more generators maintained at key locations. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-13	Maintain Water Shortage Response Plan in accordance with State Emergency Management Division and Division of Water Resources requirements for IBT certificate.	All	High	Cary Water Resources	Local	Completed	Drought or other conditions have not warranted activation of Response Plan. However Plan is in place if needed. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-14	Continue to develop emergency mutual aid water supply program.	Drought	Moderate	Cary Water Resources	Local, Regional	Completed	Mutual Aid Agreements now exist with Raleigh, Durham, and OWASA. Water was provided to Durham on short term basis in order to address water line break. Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-15	Maintain and enforce Water Conservation Policy and Program.	Drought	Moderate	Cary Water Resources	Local	Completed	See items ES-14 and PI-7. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-16	Establish a relationship/partnership with the Renaissance Computing Institute (RENCI) to create a web-based tool capable of providing real-time data to emergency managers and historic data for future emergency response planning.	All	High	Cary Technology Services	Local	Deleted	Merged with ES-4.
Public Education and Awareness							
PEA-1	Town provides technical assistance to citizens that request help with drainage concerns.	Flood	Moderate	Cary Water Resources	Local	Completed	Assistance provided to approx 150-200 citizens per year. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
PEA-2	Stormwater staff provides the public with flood zone information via the telephone, e-mail or walk-in.	Flood	High	Cary Water Resources	Local	Completed	Information provided to approximately 50 callers or visitors per year. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
PEA-3	The Town provides environmental education on website by supplying information on flood hazards, development regulations, etc.	Flood	Moderate	Cary Water Resources	Local	Completed	Website is maintained and updated as new information becomes available. Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-4	The Town maintains a "stormwater hotline" for citizens to report flooding problems during non-working hours, weekends and holidays.	Flood	High	Cary Water Resources and Public Works	Local	Completed	Town has consistently responded to and tracked calls regarding flooding problems. Number of calls varies greatly from month to month depending and number, type and severity of weather events. *(Example, 22 in Feb 2014, 69 in April 2014)* Represented in Capability Assessment. Will remove from Mitigation actions in next update.
PEA-5	Town provides education programs at environmental education centers, e.g. Hemlock Bluffs.	Flood, Drought	Moderate	Cary Parks, Recreation and Cultural Resources	Local	Deleted	Action Item to be removed. Specific programs related to flood and drought not provided due to competing PCRC priorities. Education and information provided in other contexts through water Resources
PEA-6	Town provides flood maps for public use with staff available for public assistance.	Flood	High	Cary Water Resources	Local	Completed	Information provided to approximately 50 callers or visitors per year. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
PEA-7	Town provides water conservation educational programs at Spring Days and Lazy Days Events held in the spring and late summer of every year.	All	Low	Cary Water Resources	Local	Completed	Information provided annually at Lazy Daze and Spring Daze festivals, and mailed each spring to all water customers at launch of summer campaign. Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-8	Provide public outreach to owners of high-hazard dams and downstream property owners. Provide information to clarify notification process prior to water release.	Flood	High	Cary Water Resources and Public Works	Local	Completed	Completed. Issue adequately addressed by Land Quality Section (LQS) of NCDENR, which requires owners to have EAP, inspects dams, and provides inspection report to owners annually or biennially. Will remove this item from Mitigation actions in next update
PEA-9	Establish a relationship/partnership with the Renaissance Computing Institute (RENCI) to create a web-based tool that will allows users to view information about the risks of natural hazards, including floods, fires, dam breaks and winter storms, in specific areas of Wake County.	All	High	Cary Technology Services	Local	Deleted	Duplication – covered in ES-4
PEA-10	Regularly review and improve means of communicating and sharing information with citizens by utilizing emerging technologies where appropriate and cost effective.	All	High	All Town Departments	Local	Completed	Town now provides information via facebook, Youtube, and twitter, news release feed, email subscription service, local cable TV and apps related to transit service and sustainability.

Town of Fuquay-Varina Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Update the Land Use Plan (LUP) update including identification of environmentally sensitive areas for evaluation and protection during development review process.	All, Flood	Moderate	Fuquay-Varina Planning	Local	December 2015 - 2016	The Town will work toward a cycle of LUP area updates within the period of this HMP. The last officially adopted update was in 2005. Lack of staffing and budget constraints have prevented update further than minor updates related to zoning changes.
P-2	Enforce 50’ riparian stream buffers in Neuse and Cape Fear River basins to restrict development in these protected areas.	Flood	High	Fuquay-Varina Planning	Local	Completed	The Town’s riparian buffer requirements in Cape Fear River Basin are additional to those required by the State for only the Neuse River Basin. Requirements enforced through new development applications since adoption in 2006.This action will be removed from the plan at the next update.
P-3	Update the Community Transportation Plan including evaluation of stream-crossings to reduce impacts on streams, flood plains and wetlands.	Flood	Moderate	Fuquay-Varina Planning	Local	December 2015	Update existing plan, adopted in 2007, to reflect changes and new developments in facilities, transportation, infrastructure, and environmental features. Overall update of the CTP is tied to the Southwest Area Study (SWAS) which was delayed for over 2 years, with adoption postponed until mid-2014.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-4	Update land Development Ordinance (LDO) to incentivize and encourage floodplains, wetlands, riparian buffers to be maintained as open space.	Flood	Moderate	Fuquay-Varina Planning and Engineering	Local	June 2015	In progress. Adoption of LDO is anticipated in June 2015, with efforts referenced to be in addition to current standards. Town Board decision on process and approval to proceed with development of the LDO delayed ability to begin.
P-5	Add standards to LDO to reduce impervious surface areas as part of landscaping requirements to reduce storm water volume and concentration in nonresidential development.	Flood	Moderate	Fuquay-Varina Planning and Engineering	Local	June 2015	In progress. Adoption of LDO is anticipated in June 2015, with efforts referenced to be in addition to current standards that will minimize impervious surface and utilize alternative construction materials to reduce runoff and impact on water courses. Action hinges on LDO.
P-6	Develop Stormwater Management Plan based on NPDES Phase II Stormwater Requirements.	Flood	High	Fuquay-Varina Engineering	Local	February 2014	Completed. Adoption of Stormwater Management Plan in February 2014 to assist in regulation of runoff control and reduced effects of hazards.
P-7	Require pre and post construction certification for residential lot development within 10 feet of Wake County Flood Hazard Soils.	Flood	Moderate	Fuquay-Varina Planning	Local	Completed	Completed. The Town requires this information with building permit for single family homes in residential developments to provide that new structures are not encroaching into environmentally sensitive areas. This action will be removed from the plan at the next update.
P-8	Enforce Wake County Flood Hazard Soils Policy, following and utilizing flood study standards.	Flood	Moderate	Fuquay-Varina Planning	Local	2015	New action. The Town enforces an adopted policy related to protection of Wake County Flood Hazard Soils.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-9	Annually calculate acreage of flood prone property preserved as open space.	Flood	Moderate	Fuquay-Varina Planning	Local	2015, Annual review and update	The Town continues to see development of subdivisions utilizing open space and thereby preserving flood prone areas. The Town is also working to connect park facilities to minimize disturbance of land, and provide connections to schools via cooperation with Wake County Board of Education.
P-10	Adopt a Land Development Ordinance that will improve the review process, standards and results to reduce the impact of development on the natural environment.	Flood	Moderate	Fuquay-Varina Planning	Local	June 2015	In progress. Anticipated adoption of LDO is June 2015. See action related to adoption of LDO.
P-11	Implement standard for each buildable lot to have a minimum percentage of buildable area outside floodplains, wetlands, riparian buffers as part of the plan review and recording process.	Flood	High	Fuquay-Varina Planning	Local	June 2015	In progress. Adoption of LDO is anticipated in June 2015, with efforts referenced to be in addition to current standards. This strategy will provide for a minimum buildable area outside of any environmentally sensitive areas that may be present. See action related to adoption of LDO.
P-12	Map storm water drainage system as part of Phase II Stormwater Management Plan.	Flood	High	Fuquay-Varina Engineering	Local	2015, Annual review and update	The Town continues to map both existing and new systems in order to provide more accurate account of facilities.
P-13	Provide for public dissemination building inspections brochures regarding high winds, water damage prevention, and tie downs for accessory structures.	Flood, Tornado, Hurricane, Thunderstorm/ High Wind	Moderate	Fuquay-Varina Inspections	Local	2015, Annual review and update	Brochures are available in public location at the Town Hall and are regularly distributed. Enforcement of the NC Building Code also furthers this effort.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Property Protection							
PP-1	Continue to enforce the Flood Damage Prevention Ordinance for all new construction or substantial building rehabilitations.	Flood	High	Fuquay-Varina Planning	Local	Completed	The review process for new development and rehab or expansion of existing development requires permittees to address any environmentally sensitive areas via the permitting process. This action will be removed from the plan at the next update.
PP-2	Require minimum finished floor elevation in known FEMA flood hazard zones be minimum 2' about base flood elevation.	Flood	High	Fuquay-Varina Planning and Inspections	Local	Completed	Enforced through building permitting and verification between departments. See PP-1 implementation status above. This action will be removed from the plan at the next update.
PP-3	Develop Stormwater Management Plan based on NPDES Phase II Stormwater Requirements to help reduce flood damages (see also P-6).	Flood	High	Fuquay-Varina Engineering	Local	Completed	Completed. Adoption of Stormwater Management Plan in February 2014 to assist in regulation of runoff control and reduced effects of hazards.
PP-4	Identify and inventory buildings that are located in FEMA flood zones to determine which structures may be prone to flooding (possible relocation and/or elevation).	Flood	High	Fuquay-Varina Planning and Engineering	Local	December 2014	In progress. Inventory to be compiled using LIDAR data recently made available, along with 2006 FEMA FIRM mapping.
Natural Resource Protection							
NRP-1	Work with the U.S. Army Corps of Engineers on wetland protection.	Flood	Moderate	Fuquay-Varina Planning	Local	2015, Annual review and update	Annual effort to minimize the impact on environmentally sensitive areas and is integral to procedures outlined in the Town's regulations.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-2	Use Open Space Ordinance to protect wildlife habitat.	All	Moderate	Fuquay-Varina Planning	Local	Completed	The open space development regulations, most commonly used residential development use in town, provide that no environmentally sensitive areas be lotted into and remain as open space. This regulation provides protection from disturbance. This action will be removed from the plan at the next update.
NRP-3	Continue to utilize Wake County Erosion and Sedimentation Control to ensure proper erosion control procedures are followed before and during construction.	Flood, Erosion	Moderate	Fuquay-Varina Planning and Inspections	Local	Completed	The Town has an ongoing relationship with Wake County Erosion Control, who is contracted to provide services listed. There is procedure to ensure that projects don't move forward to construction from plan review without being reviewed by WCEC. This action will be removed from the plan at the next update.
NRP-4	Notify Wake County of any illegal stream dumping instances	Flood	Moderate	Fuquay-Varina Public Utilities, Wake County Environmental Services	Local	Completed	The Town continues to work with Wake County on illegal dumping to maintain free flow in water ways and reduce runoff and impacts to downstream structures. This action will be removed from the plan at the next update.
NRP-5	Incorporate regulations for illicit discharge control in Phase II Stormwater Management Plan.	Flood	Moderate	Fuquay-Varina Engineering	Local	February 2014	Completed. Adoption of Stormwater Management Plan in February2014 to assist in regulation of runoff control and reduced effects of hazards.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-6	Enforce standards for tree protection and control of clear cutting (Town has received legislative authority to enact tree protection and control of clear cutting standards.)	Flood	High	Fuquay-Varina Planning	Local	Completed	The Town's program has been in place since 2007 and is a standard used with new developments to minimize erosion and maintain vegetative areas. This action will be removed from the plan at the next update.
Structural Projects							
SP-1	Incorporate on-site retention/detention requirements for Phase II Stormwater Management Plan.	Flood	High	Fuquay-Varina Engineering	Local	Completed	Completed. Adoption of Stormwater Management Plan in February 2014 to assist in regulation of runoff control and reduced effects of hazards.
Emergency Services							
ES-1	Maintain current warning system with local sirens on elevated platforms and use of the Emergency Broadcast System.	All	High	Fuquay-Varina Fire, Police, and Wake County Emergency Management	Local, County, State	Completed	Land officials work with County and others in order to ensure proper maintenance of equipment. This action will be removed from the plan at the next update.
ES-2	Examine need to evaluate weather radio distribution program (daycares/nursing homes) initiated by Wake County Emergency Management 1999	All	Moderate	Wake County Emergency Management	County	2015, Annual review and update	This strategy is annually updated, as the need is subject to change over time, but has not yet been determined to be such a need that implementation is necessary.
ES-3	Revise current (1977) Town ordinance regarding civil preparedness	All	Moderate	Fuquay-Varina Fire and Police	Local	Completed	Completed. In 2006, the Town adopted a new Emergency Operations Plan and Disaster Operations Plan with funding though WCEM, with the plan mirroring the Wake County plan with the exception of personnel and responsibilities.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-4	Update and implement a Basic Emergency Operations Plan and a Disaster Operations Plan for the Town.	All	Moderate	Fuquay-Varina Fire and Police	Local	June 2016	Update necessary aspects of plans, adopted in 2006, for relevance, personnel, and responsibilities.
ES-5	Coordinate an incident command course for all Town employees, related to Emergency Operations Plan and Disaster Operations Plan for the Town.	All	Moderate	Fuquay-Varina Fire and Police	Local	November 2016	New action. Provide training on general and updated plans to be better prepared for implementation if necessary.
ES-6	Conduct a scenario-based training exercise, related to Emergency Operations Plan and Disaster Operations Plan for the Town.	All	Moderate	Fuquay-Varina Fire and Police	Local	March 2017	New action. Conduct a training exercise to further objective of training and preparedness for employees.
ES-7	Assist Wake County Emergency Management with updating list of local hazardous materials sites.	All	Moderate	Fuquay-Varina Fire and Wake County Emergency Management	Local, County	Completed	Town departments work regularly and closely with WCEM to ensure coordination on known hazardous sites. Facilities are reviewed and inspected, with Fire Department involved in plan review prior to development. This action will be removed from the plan at the next update.
ES-8	Continue Pre-Fire Incident Plan program for all commercial facilities within the Town limits.	All	High	Fuquay-Varina Fire	Local	Completed	nspections of commercial facilities occur at regular intervals in an effort to ensure maintenance and consistency with initial approval. Fire hazards are thereby reduced. This action will be removed from the plan at the next update.
ES-9	Address securing and cleaning up affected hazardous areas when revising Disaster Operations Plan.	All	High	Fuquay-Varina Fire and Police, Wake County Emergency Management and North Carolina Highway Patrol	Local, County	Completed	Completed. This item has been implemented as referenced, but may also be updated in accordance with updates to Emergency Management Plan, as referenced in action item above.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-10	Continue to evaluate and improve response and recovery methods following each hazard event.	All	High	Fuquay-Varina Fire and Police	Local	Completed	This is an ongoing process to improve and evaluate responses and recovery methods for hazard events. Training and post evaluation help improve capabilities. This action will be removed from the plan at the next update.
ES-11	Examine the feasibility and need to contract/purchase a reverse 911 system to alert citizens of impending danger.	All	Moderate	Fuquay-Varina Fire, Police, Information Technology and Public Information	Local	June 2016	In progress. The idea of a reverse system must be vetted for feasibility and cost-benefit of implementation to minimize possible loss of life.
ES-12	Finalize implementation of new/updated radio communication equipment.	All	Moderate	Fuquay-Varina Fire and Police	Local	January 2017	New action. Beginning in 2013, radio communication equipment replacement is currently occurring, with completion anticipated in January 2017.
Public Education and Awareness							
PEA-1	Maintain floodplain maps for public use and produce other maps as needed.	Flood	Moderate	Fuquay-Varina Planning and Engineering	Local	2015, Quarterly review and update	The Town maintains a website with up-to-date flood mapping. The Town provides printed maps as requested and updates maps for public display approximately quarterly. Other maps, such as transportation or land use maps, include environmental information to help support protection.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-2	Develop and maintain a hazard mitigation section on the Town website that is updated every 5 years as the plan is updated.	All	High	Fuquay-Varina Planning and Information Technology	Local	Completed	The Town's webpage dedicated to the HMP is user-friendly and easy to understand for the general public, and is regularly reviewed for relevant content and updated as appropriate. This action will be removed from the plan at the next update.
PEA-3	Collect educational materials on disaster preparedness and display at public library and local government offices.	All	High	Fuquay-Varina Planning, Inspections, Police, and Fire	Local	Completed	The Town makes available brochures and materials at a public location in Town Hall for anyone interested. The plan was provided to the local public library in 2004 and since. This action will be removed from the plan at the next update.
PEA-4	Educate public on importance of channel maintenance as part of Phase II Stormwater Management Plan.	Flood	Moderate	Fuquay-Varina Engineering	Local	Completed	In previous years through 2014, the Town has partnered with the Clean Water Education Partnership for material dissemination at events. This action will be removed from the plan at the next update.
PEA-5	Work with local real estate agents to ensure that potential buyers are aware of properties that are exposed to potential flood damage.	Flood	Moderate	Fuquay-Varina Planning	Local	Completed	Staff works with agents regarding any questions they propose. The same sources of information references in PEA-1 above are available for use. This action will be removed from the plan at the next update.
PEA-6	Require delineation of Wake County Flood Hazard Soils, FEMA flood zones, and wetlands on final plats.	Flood	Moderate	Fuquay-Varina Planning	Local	Completed	The Town makes every effort to include information on final subdivision plats. This action will be removed from the plan at the next update.

Town of Garner Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Institute NPDES Phase II Stormwater Program.	Flood Drought	High	Garner Engineering	High	Completed	This program has been implemented and so the action will be removed from this plan in the next update.
P-2	Evaluate the need for regulations to encourage use of low impact development site planning principles to help control stormwater volume impacts.	Flood, Dam	Moderate	Garner Engineering and Planning	Moderate	2018	Low impact development principles have been evaluated, but more regulations concerning stormwater could improve flood issues.
P-3	Enforce zoning ordinance standards that help minimize impervious surface coverage in priority and healthy watersheds.	Flood	Moderate	Garner Engineering and Planning	Moderate	Completed	This ordinance has been implemented and so the action will be removed from this plan in the next update.
P-4	Continue to ensure good site planning by carefully reviewing development plans, meeting with developers and making site inspections to ensure existing soil erosion and sedimentation control regulations are being implemented properly.	Flood	High	Garner Engineering and Wake County	High	Completed	These regulations have been implemented and so the action will be removed from this plan in the next update.
P-5	Establish an open space prioritization and acquisition program to ensure maximum success with limited funds.	Flood	High	Garner Board of Aldermen and Parks and Recreation	High	Completed	Since the Town of Garner recently developed a 96 acre passive park in 2006-2007 this is no longer at the top of the priority list.
P-6	Partner with Wake County and other interested parties to jointly identify and acquire open space lands.	All Hazards	High	Garner Board of Aldermen and Wake County and Open Space Advisory Committee	High	2018	Planning interlocal agreement with City of Raleigh for stewardship of open space/ conservation property in Garner. This action will be worked on going forward.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-7	Adopt Comprehensive Land Use Plan that will provide a 20-year plan for town growth and include goals and policies for public safety and hazard mitigation.	All Hazards	High	Garner Planning	High	Completed	The comprehensive plan was adopted in 2006.
P-8	UDO: Continue to provide stream and creek buffers, and floodplain and wetland protection.	Flood	High	Garner Planning	High	2017	Stream and creek buffers are in place, but additional measures to protect floodplains and wetlands could be useful going forward.
P-9	UDO: Subdivision Standards – Continue to provide protection for residential areas by not allowing residential lots in the floodplain.	Flood	High	Garner Planning	High	Completed	Residential lots are not allowed in the floodplain so this action will be removed from the next update.
P-10	UDO: Watershed Protection Overlay District – Ensure riparian buffers are provided for perennial and intermittent streams, lakes, and ponds.	Flood	High	Garner Planning and Public Works	High	Completed	Riparian buffers are provided for intermittent streams, lakes, and ponds so this action will be removed from the next update.
P-11	Provide adequate water supply through storage and interconnection with other public water systems.	Drought	Moderate	City of Raleigh and Garner Engineering	Moderate	2018	City of Raleigh utilities currently using Lake Benson as primary water source. Additional water sources should be evaluated going forward.
P-12	Provide backup power for all critical public facilities (Police, Public Works, and other critical public buildings).	All Hazards	Moderate	Garner Administration	Moderate	2019	Town Hall Complex and Public Works completed; New Police Facility planned with generator
P-13	Maintain major town transportation routes through snow and ice removal including experimenting with brine in 2004.	Severe Winter Storms	Moderate	Garner Public Works	Moderate	Completed	Use of brine has proven effective in snow and ice removal. This strategy will be continued in the future.
P-14	On a regular basis, continue to back-up information pertaining to Town government in case of an emergency.	Flood, Hurricane and High winds, Tornado, Winter, Dam	Moderate	Garner Computer Information Services	Moderate	Completed	Critical financial data backed up offsite.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-15	Garner Transportation Plan – Continue to address disaster preparedness (evacuation) through road interconnectivity, paved roads, and widening of roads.	Flood, Hurricane and High winds, Tornado, Winter	Moderate	Garner Planning and Public Works	Moderate	2019	This plan has been implemented, but it will require review and update to account for new development and changes in overall transportation system
P-16	Evaluate ways to amend landscape ordinance requirements regarding the maintenance of pervious surface areas for natural stormwater water detention.	Flood	Moderate	Garner Planning	Moderate	Completed	There has been an informal practice to require this during site approval, particularly as it related to landscaping in BMP's since June 2007
P-17	Incorporate Greenway Plan into Open Space Plan.	Flood	Moderate	Garner Planning and Parks and Recreation	Moderate	Completed	The Greenway plan has been incorporated into the Open Space plan since it was adopted in 2006
P-18	Incorporate requirement for open space set aside in residential and multi-family projects.	Flood	Moderate	Garner Planning	Moderate	Completed	There is a requirement for open space set-asides in residential and multi-family projects.
P-19	Develop for public dissemination building inspections brochures regarding high winds, water damage prevention, and tie downs for accessory structures.	Flood, Hurricane and High winds, Tornado, Winter	Moderate	Garner Inspections	Moderate	2018	The Town website was recently redesigned and this information was not included. Going forward, more information will be included on reducing damage and mitigation.
P-20	Building Code - The Town administers a program upholding the 2002 International Building Code with North Carolina Amendments. These regulations provide guidance for design criteria for flood, roof snow load, winter design, wind speed, seismic design, weathering, frost line depth, termite infestation, and decay.	Flood, Hurricane and High winds, Tornado, Winter	High	Garner Inspections	High	Completed	The town administers the NC Building Code so this action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-21	Comprehensive Growth Plan - The Town has an existing Comprehensive Plan which includes Land Use, Parks and Recreation, Public Safety, Housing, economic Development, Transportation, Public Utilities and Environment. This plan includes past and current conditions and sets goals for future needs of the Town.	All Hazards	Moderate	All	Moderate	Completed	The town has its Comprehensive Growth Plan in place so this action will be removed from the next update.
P-22	Land Use Plan - An existing tool which guides development based on proposed future land use designations, available services, and existing site features to ensure that future development is meeting the overall vision of the Town while ensuring the safety of citizens.	Flood, Hurricane and High winds, Tornado, Winter, Wildfire, Dam	High	Garner Planning	High	Completed	The town has its Land Use Plan in place so this action will be removed from the next update.
P-23	Floodplain Development Regulations – Ordinance to minimize public and private losses due to flood conditions.	Flood	High	Garner Engineering	High	Completed	The town has Floodplain Development Regulations in place so this action will be removed from the next update.
P-24	Floodplain Development Regulations - Town is a participating member of the National Flood Insurance Program and is considering actively participating in the Community Rating System to help monitor hazard mitigation efforts and to improve the affordability of flood insurance for citizens.	Flood	High	Garner Engineering	High	Completed	The town has Floodplain Development Regulations in place so this action will be removed from the next update.
P-25	Open Space Preservation - The Town has an existing Open Space Master Plan which identifies and evaluates various land and open space resources throughout the ETJ and Urban Service areas of the Town. The Plan has been used to develop a prioritization system that is used by all Town departments to identify properties to acquire or require as open space.	Flood	High	Garner Parks and Recreation	High	Completed	The town has an Open Space Master Plan in place so this action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-26	Unified Development Ordinance (UDO) – Existing UDO regulates development to ensure safety from fire, panic and other dangers. The UDO provides for orderly growth and development within the Town and ETJ by determining appropriate land use and development standards.	Flood, Hurricane and High winds, Tornado, Winter, Wildfire, Dam	High	Garner Planning	High	Completed	The town has a Unified Development Ordinance in place so this action will be removed from the next update.
P-27	The Town will inventory all its structures located within or immediately adjacent to known flood hazard areas.	Flood	Moderate	Garner Planning and Engineering	Moderate	2017	The Town evaluated properties in 2008 and flood insurance was purchased for properties in the floodplain. However, this inventory needs to be updated and re-evaluated to ensure proper mitigation.
P-28	The Town will seek opportunities to use Federal grant resources to assist private property owners in elevating existing structures located within flood hazard zones.	Flood	Moderate	Garner Planning and Engineering	Moderate	2019	Town pursued this but does not have a history of high flood risk properties. The town will continue to evaluate and seek funding opportunities to mitigate flood prone properties in the future.
Property Protection							
PP-1	The Town has a service to respond to requests and questions from citizens regarding actions they may take to improve drainage, halt erosion, and to relocate, renovate or retrofit structures being flooded.	Flood	Moderate	Garner Engineering	Local, Private	2015, Annual updates	The Town has a service to respond to requests and questions from citizens regarding actions they may take to improve drainage, halt erosion, and to relocate, renovate or retrofit structures being flooded. This program will be updated and reevaluated each year

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PP-2	Minimum Housing Standards Ordinance - The Town has a program which inspects existing structures to ensure that they meet the minimum housing standards. Owners of structures that do not meet these requirements will be ordered to bring the structure up to minimum standards or have the structure demolished or removed.	Flood, Hurricane and High winds, Tornado, Winter	High	Garner Inspections	Local	Completed	The town has a Minimum Housing Standards Ordinance in place so this action will be removed from the next update.
PP-3	Building Retrofit - The Town is willing to develop a plan to utilize Federal grant resources to assist private property owners in renovating and retrofitting existing structures.	Wind	Low	Garner Inspections	Local, Federal	2018	Thus far, have not had property owners to request this resource, but the town will continue to work to develop a plan to implement retrofits for future residents who so desire.
PP-4	Purchase of Open Space, Parks and Greenways – The Town works with Wake County and other agencies to find other funding for open space acquisition. Once funds are obtained the Town will acquire land consistent with Land Use and Master Open Space Plans.	Flood	Moderate	Garner Parks and Recreation	Local	Completed	The Town works with Wake County and other agencies to find other funding for open space acquisition. Once funds are obtained the Town will acquire land consistent with Land Use and Master Open Space Plans. This action has been completed so it will be removed from next update.
PP-5	Engineering Department will actively respond to flooding concerns from property owners after heavy rain events	Flood	Moderate	Garner Engineering	Local	Completed	Town response based on Town Drainage Policy. This action will be removed from the next update.
PP-6	When feasible, Town of Garner will alleviate flooding into habitable space due to storm water, as consistent with Town Drainage Policy.	Flood	Moderate	Garner Engineering, Town Council	Local	2019	Although many modifications have been made, the town will work to improve its overall stormwater drainage system going forward.
PP-7	Maintain a record of approved Letters of Map Change to continue compliance with NFIP.	Flood	Moderate	Garner Engineering	Local	Completed	The town maintains these letters and will continue to do so. This action will be removed from the next plan upate.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Natural Resource Protection							
NRP-1	The Town has adopted cluster subdivision regulations and a recreation land dedication ordinance to enhance conservation efforts.	Flood, Hurricane and High winds, Tornado, Wildfire, Winter	High	Garner Planning	Local	Completed	The Town has adopted cluster subdivision regulations and a recreation land dedication ordinance to enhance conservation efforts. This action will be removed from the next update.
NRP-2	Develop and adopt a conservation subdivision ordinance to help preserve significant natural features.	Flood, Hurricane and High winds, Tornado, Winter	Moderate	Garner Planning	Local	2017	This will become a long term goal. The Cluster Subdivision meets a majority of the criteria, but more effort will be made to preserve natural features.
NRP-3	UDO 6.1.12 – Continue to require engineered stormwater controls including stream and wetland protection.	Flood, Dam	Moderate	Garner Planning and Engineering	Local	Completed	The town's UDO is in place so this action will be removed from the next update.
NRP-4	Continue to work with the U.S. Army Corps of Engineers on wetland protection.	Flood	Moderate	Garner Planning and Engineering	Local	2018	Some efforts at wetland protection have been made over the last 5 years, but more work is necessary so the town will aim to provide more protection going forward.
NRP-5	Use Open Space Ordinance to protect wildlife habitat.	Flood, Hurricane and High winds, Tornado, Wildfire, Winter	Moderate	Garner Planning	Local	2017	The Open Space Ordinance will be utilized to protect wildlife habitat going forward even though it has not been used to a large degree in the past.
NRP-6	Continue to utilize Wake County Erosion and Sedimentation Control to ensure proper erosion control procedures are followed before and during construction.	Flood, Dam, Erosion	Moderate	Garner Planning and Engineering	Local	Completed	Wake County Erosion and Sedimentation Control has been utilized to reduce erosion and the system is in place so this action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-7	Notify Wake County of any stream dumping instances.	Flood	Moderate	Garner Engineering	Local	Completed	A system of notifying the county is in place so this action will be removed from the next update.
NRP-8	Incorporate regulations for illicit discharge control in Phase II Stormwater Management Plan.	Flood	Moderate	Garner Engineering	Local	Completed	Regulations for illicit discharge control have been integrated so this action will be removed from the next update.
NRP-9	Develop standards for tree protection and regulations governing clear cutting.	Flood, Wildfire	High	Garner Planning	Local	Completed	Standards for tree protection have been developed so this action will be removed from the next update.
NRP-10	Best Management Practices (BMPs) - The Town will include in the stormwater management plan (being developed with the Town NPDES Phase II Program) BMPs that will address both water quality and water quantity management on sites.	Flood, Dam	Moderate	Garner Engineering	Local	Completed	BMPs are the typical process for site plan approval so this action will be removed from the next update.
NRP-11	Stream Dumping – In developing the NPDES Phase II Stormwater program, the Town will design and implement an illicit discharge program which will establish regulations against stream dumping.	Flood	Low	Garner Engineering	Local	Completed	The town has developed a program that establishes regulations against stream dumping so this action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-12	Wetlands Protection - The Town has existing Riparian Buffer, Open Space, and Flood Damage Prevention ordinances that restrict development along streams and in the floodplain thus restricting development in much of the Town's wetland areas. Engineering Design Standards require that all impacts to wetlands be permitted by the U.S. Army Corps of Engineers and the NCDENR Division of Water Quality prior to issuance of a Land Disturbance Permit. The Town also has an existing program that ensures that structures, through review of the Building Permit application, are not constructed in the wetlands unless permitted by the appropriate Federal and State Agencies.	Flood	Moderate	Garner Engineering, Parks and Recreation, and Inspections	Local	Completed	The town has developed a program for wetlands protection so this action will be removed from the next update.
Structural Projects							
SP-1	Pursue stream restoration projects	Flood	High	Garner Engineering	Local, Regional, State, Federal	2019	The Town will continue to actively pursue stream restoration projects and will look for ways to expand the program through partnerships with various entities.
SP-2	Incorporate on-site retention/detention requirements for Phase II Stormwater Management Plan.	Flood	High	Garner Engineering	Local	2015	Phase II plan approved by NC Department of Environment and Natural Resources Waiting for comment period to end.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Emergency Services							
ES-1	Identify priority Town facilities and provide access to one main entrance. Restore life safety and building systems as needed.	Flood, Hurricane and High winds, Tornado, Winter	High	Garner Public Works	Local, FEMA	Completed	Town crews on standby during and after storms to clear roads and crucial Town facilities. Also, Town Hall and Police Station have standby generator for power outages. Since this system is in place, this action will be removed at the next update.
ES-2	Develop a Business Continuity Plan that is the primary document housing all disaster related plans and procedures including Hazard Mitigation Plan, Debris Management Plan, Multi-Hazard Plan as well as disaster response plans for all Town departments.	Flood, Hurricane and High winds, Tornado, Winter	High	Garner Police and Public Works	Local	2018	Town entered into a cooperative contracting agreement with the county for Disaster Debris Cleanup and monitoring in 2013. No formal disaster debris plan has been adopted.
ES-3	Emergency Operations Command Post Center – established when natural hazard imminent. Center coordinates evacuations, sheltering, staging areas for equipment, manpower, and needed supplies. Equipment includes internet access, telephone, wireless communications, radio and backup supplied by emergency batteries and/or generators.	Flood, Hurricane and High winds, Tornado, Winter, Wildfire	High	Garner Police	Local	April 2015	Plans are underway to build a new police facility that will have the capability of acting as an EOC.
ES-4	Health and safety maintenance – provide assistance with security and post storm clean-up.	Flood, Hurricane and High winds, Tornado, Winter	High	Garner Police , Public Works, and EMS	Local	Completed	The town has a system in place to maintain health and safety post-storm so this action will be removed from next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-5	Post disaster response – building inspections. Inspector team does post disaster damage assessment using FEMA guidelines.	Flood, Hurricane and High winds, Tornado, Winter	Moderate	Garner Inspections	Local	Completed	Inspector team does post disaster damage assessment using FEMA guidelines. This action will be removed from next update.
ES-6	Continue to evaluate and improve response and recovery methods following each hazard event.	Flood, Hurricane and High winds, Tornado, Winter, Wildfire	High	Garner Police	Local	Completed	The town will review and update its response and recovery methods after each hazard event. This action will be removed from next update.
ES-7	Tracking of Known Drainage, Erosion and Flooding Problems - The Town has a current program to track drainage complaints, flooding and erosion problems within the town limits and ETJ.	Flood	Moderate	Garner Engineering	Local	Completed	The Town has a current program to track drainage complaints, flooding and erosion problems within the town limits and ETJ. This action will be removed from next update.
ES-8	Mobile Command Post - Available 24 hours a day and equipped to communicate with all agencies in the Triangle including Emergency Management, State agencies, fire departments, etc. The Town will be upgrading this service.	All Hazards	High	Garner Police	Local, State	2018	Available 24 hours a day and equipped to communicate with all agencies in the Triangle including Emergency Management, State agencies, fire departments, etc. The Town will be upgrading this service. Add to Town's CIP for future funding.
Public Education and Awareness							
PEA-1	Stormwater staff provides flood information through calling or e-mail program to any inquirer. County requires that flood zone information be shown on all plats recorded within the Town planning jurisdiction.	Flood	High	Garner Engineering	Local	Completed	Stormwater staff provides flood information through calling or e-mail program to any inquirer. County requires that flood zone information be shown on all plats recorded within the Town planning jurisdiction. This action will be removed from next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-2	Town website will be updated to answer citizen questions about flood hazards, flood safety, availability of flood insurance, stormwater regulations, and other information.	Flood	Moderate	Garner Engineering	Local	2015	Engineering department will add storm water and floodplain information to the website
PEA-3	Town website will be updated with public access to information pertaining to evacuation routes, emergency contact numbers, and detailed weather reports in case of emergency.	Flood, Hurricane and High winds, Tornado, Winter, Wildfire	Moderate	Garner Computer Information Services	Local	2015	Since this activity is headed by Wake County Emergency Management, the Town will include a link on its website.
PEA-4	Continue to update flood hazard maps to reflect new subdivisions, changes in corporate limits, and any new DFIRM data as provided by the County.	Flood	Moderate	Garner Engineering and Planning	Local	Completed	Flood plain maps updated. Garner saw little to no change in base flood elevations
PEA-5	Planned park land purchase – nature park to include trails and environmental education center.	Flood	High	Garner Parks and Recreation, POSE	Local, Wake County, State Grant	Completed	Town completed development of White Deer Park in October 2009. It has a LEED certified Nature Center that focuses on environmental education. It preserves open space and has several BMPs for water quality and quantity.
PEA-6	Maintain floodplain maps for public use and produce other maps as needed.	Flood	Moderate	Garner Engineering	Local	Completed	The town has floodplain maps and other maps showing flood risk. This action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-7	Develop and maintain a hazard mitigation section on the Town website.	All Hazards	Moderate	Garner Administration and Computer Information Services	Local	2015	The Town website was recently redesigned and a hazard mitigation section was not included. However, the Hazard Mitigation Plan has been posted on the Town website. A separate section will be created and information added.
PEA-8	Collect educational materials on disaster preparedness and display at public library and local government offices.	Flood, Hurricane and High winds, Tornado, Winter, Dam	High	Garner Administration	Local	Completed	The Town posts the "Ready Wake" brochures created by Wake County in Town Hall buildings during hurricane season so this action will be removed from the next update.
PEA-9	Map Information - The Town maintains current FIRM maps/studies for Town limits and ETJ. Town also maintains current land use, structure, and development maps. All maps are available for public use.	Flood, Wildfire	High	Garner Engineering and Planning	Local	Completed	The Town maintains current FIRM maps/studies for Town limits and ETJ. Town also maintains current land use, structure, and development maps. All maps are available for public use.
PEA-10	Website - The Town maintains its own website which is able to provide up to date information for the public. Town continuously updates the site with additional resources.	All Hazards	High	Garner Town Council, Computer Information Services, All Departments	Local	2018	The Town website was recently redesigned. Going forward, more information will be included on reducing damage and mitigation.
PEA-11	Website- Create link to Wake County Hazard Mitigation Plan.	All Hazards	Moderate	Garner Computer Information Services	Local	Deleted	Combine with PEA-7

Town of Holly Springs Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Adopt Building Code	All	High	Holly Springs Code Enforcement	Local	Completed	The Town administers a program upholding the 2002 International Building Code with North Carolina Amendments. These regulations provide guidance for design criteria for flood, roof snow load, winter design, wind speed, seismic design, weathering, frost line depth, termite infestation and decay. This action will be removed from the next update
P-2	Develop Vision Holly Springs Comprehensive Plan	All	Moderate	Holly Springs Planning & Zoning	Local	Completed	The Town has an existing Comprehensive Plan which includes Land Use, Parks and Recreation, Public Safety, Economic Development, Transportation, Public Utilities and Environment. This plan includes past and current conditions and sets goals for future needs of the Town. The Hazard Mitigation Plan will be incorporated as an additional component of the CGP at plan update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-3	Develop Land Use Plan	All	High	Holly Springs Planning & Zoning	Local	Completed	This is an existing tool which guides development in Town based on proposed future land use designations, available services, and existing site features to ensure that future development is meeting the overall vision of the Town while insuring the safety of its citizens. This action will be removed from the next update
P-4	Implement Floodplain Development Regulations to minimize public and private losses due to flood conditions.	Flood	High	Holly Springs Engineering	Local	Completed	The Town has an ordinance developed to minimize public and private losses due to flood conditions. The latest update of the Flood Damage Prevention Ordinance was May 2, 2006. (00-23) This action will be removed from the next update
P-5	Implement Floodplain Development Regulations to restrict or prohibits uses which are dangerous to health, safety and property	Flood	High	Holly Springs Engineering	Local	Completed	The Town restricts or prohibits uses which are dangerous to health, safety and property due to water or erosion hazards or which result in damaging increases in erosion or in flood heights or velocities. (00-23) This action will be removed from the next update
P-6	Implement Floodplain Development Regulations that require that uses vulnerable to floods be protected against flood damage at the time of initial construction	Flood	High	Holly Springs Engineering	Local	Completed	The Town has a program that requires that uses vulnerable to floods be protected against flood damage at the time of initial construction. (00-23) This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-7	Implement Floodplain Development Regulations to control the alteration of natural floodplains, stream channels and natural protective barriers	Flood	High	Holly Springs Engineering	Local	Completed	The Town has an ongoing program that controls the alteration of natural floodplains, stream channels and natural protective barriers which are involved in the accommodation of flood waters (00-23) This action will be removed from the next update
P-8	Implement Floodplain Development Regulations to control filling, grading, dredging and other development	Flood	High	Holly Springs Engineering	Local	Completed	The Town has an ongoing program that controls filling, grading, dredging and other development which may increase erosion or flood damage (00-23) This action will be removed from the next update
P-9	Implement Floodplain Development Regulations related to participating in the National Flood Insurance Program	Flood	High	Holly Springs Engineering	Local	2016	The Town evaluated the Town's potential participation in the Community Rating System (CRS) and determined that the amount of insured properties in the Town did not warrant participation in the CRS. However, staff will reevaluate this determination in the future through the implementation of the Floodplain Management Program. Will re-evaluate in 2016.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-10	Implement Floodplain Development Regulations – to prevent or regulate the construction of flood barriers which will unnaturally divert flood waters	Flood	High	Holly Springs Engineering	Local	Completed	The Town has an ongoing program that prevents or regulates the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards to other lands (00-23). This action will be removed from the next update
P-11	Increase Open Space Preservation	Flood	High	Holly Springs Parks & Recreation	Local State	Completed	The Town has an existing Open Space Master Plan which identifies and evaluates various land and open space resources throughout the ETJ and Urban Service areas of the Town. The Plan is used to develop a prioritization system that can be used by all Town departments for identifying properties to acquire or require as open space from developers as the Town grows. This action will be removed from the next update
P-12	Adopt Unified Development Ordinance (UDO)	All	High	Holly Springs Planning & Zoning	Local	2015, review and update annually	The Town has an existing UDO which regulates development to ensure safety from fire, panic and other dangers. The UDO provides for orderly growth and development within the Town and ETJ by determining appropriate land use and development standards. The UDO is in place, but the town will update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-13	Adopt Water Shortage and Conservation Ordinance	Droughts and Heat Waves	High	Holly Springs Engineering	Local	Completed	The Town has an existing ordinance that is designed: (1) to implement permanent seasonal water conservation measures; (2) to provide for the declaration of increasingly serious stages of water shortages, and (3) to define mandatory water conservation measures to be implemented during these various stages. The Water Shortage and Conservation Ordinance is intended to preserve the water resources of the Town under specific conditions so that water demands for human consumption, sanitation, and fire protection can be met as cost-efficiently as possible throughout the service area. (98-10). This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-14	Adopt Stormwater Management Regulations	Flood	High	Holly Springs Engineering	Local	2019	The Town maintains numerous basin HEC-HMS and HEC-RAZ models to determine the water surface elevation where nuisance flooding is a known problem. To ensure that water surface elevations and velocities in the streams do not get worse, the Town has adopted a policy to require new development, to run the model with the proposed development and to add stormwater BMPs or other measures to make sure that there is not a negative impact downstream. When new developments occur, models will need to be re-run.
P-15	Carry out Water System Vulnerability Assessment	All	High	Holly Springs Public Utilities, Engineering	Local	Completed	This assessment was completed in 2004
Property Protection							
PP-1	Implement Minimum Standards Ordinance	All	High	Holly Springs Code Enforcement	Local	Completed	The Town has a program which inspects existing structures to ensure that they meet the Minimum Housing Standards Ordinance. Structures that do not meet these requirements will be ordered to bring up to minimum standards, demolished or removed. Safety officer in code enforcement department handles this program. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PP-2	Barrier Installation.	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town has an ongoing program that prevents or regulates the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards to other lands (00-23). The NPDES Phase II Stormwater Illicit Discharge Detection & Elimination Regulations has provisions for watercourse protection which requires property owners to keep and maintain the watercourse free of trash, debris, excessive vegetation and other obstacles that would pollute, contaminate or significantly retard flow of the water through the watercourse. This action will be removed from the next update
PP-3	Building Acquisition and Clearance - The Town is willing to develop a plan designed to utilize Federal grant resources to assist private property owners in purchasing properties located in flood hazard zones.	Flood	Low	Holly Springs Code Enforcement	Local, State, Federal	2017	No such program is in the works at this time. The town will need to evaluate properties that are potentially eligible and determine if funding is available
PP-4	Building Elevation.	Flood	High	Holly Springs Engineering	Local, State, Federal	Completed	The Town has an existing program which requires all residential and commercial finished floors to meet a minimum of 2-foot freeboard over the base flood elevation. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PP-5	Building Relocation - The Town is willing to develop a plan designed to utilize Federal grant resources to assist private property owners in relocating existing structures out of flood hazard zones.	Flood	Low	Holly Springs Code Enforcement	Local, State, Federal	2017	No such program is in the works at this time. The town will need to evaluate properties that are potentially eligible and determine if funding is available
PP-6	Building Retrofit - The Town is willing to develop a plan to utilize Federal grant resources to assist private property owners in renovating and retrofitting existing structures in flood hazard zones to reduce vulnerability to flooding damage.	Flood	Low	Holly Springs Code Enforcement	Local, State, Federal	2017	No such program is in the works at this time. The town will need to evaluate properties that are potentially eligible and determine if funding is available
PP-7	Bass Lake Area Plan - Design a plan specific to the Bass Lake line to determine mitigation in the event of a spill or disaster.	Flood	High	Holly Springs Public Utilities Public Works	Local	Deleted	Removed from actions due to infeasibility
PP-8	Outfall Maintenance	Flood	High	Holly Springs Public Works	Local	Completed	Continue sewer easement clearing and aerial main inspections/clearing to prevent and eliminate obstructions and erosion that can lead to infrastructure failure, as required by NC DENR DWQ regulations. The Town also uses cameras and jet smoke for inspection purposes.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PP-9	Purchase of Open Space, Parks and Greenways	Flood	Moderate	Holly Springs Parks and Recreation	Local	2018	The town has acquired hundreds of acres of open space in recent years. The Parks and Recreation Department is asking for $500,000 for Capital Improvement Projects to purchase open space. The Town also works with Wake County and other agencies to find other funding for open space acquisition. Once funds are obtained the Town will acquire land consistent with Land Use and Master Open Space Plans.
PP-10	Enforce Open Space Requirements	Flood	Moderate	Holly Springs Parks and Recreation	Local	Completed	The Town requires every subdivision to provide open space or a fee-in-lieu which will be used to purchase property consistent with Land Use and Master Open Space Plans. This action will be removed from the next update
Natural Resource Protection							
NRP-1	Institute Best Management Practices (BMPs) for NPDES Phase II Post-Construction Stormwater Regulations	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town adopted NPDES Phase II Post-Construction Stormwater Regulations on November 6, 2007 and updated Section 8 of the Engineering Design & Construction Standards to address both water quality and water quantity management on sites. Staff is currently implementing this program. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-2	Develop Erosion and Sedimentation Control program	Flood	Moderate	Holly Springs Engineering	Local	Completed	Local program to enforce Erosion and Sedimentation Control standards. Local sedimentation control program complements state program.This action will be removed from the next update
NRP-3	Encourage good Forestry Practices.	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town has an existing program which requires a separate timbering plan within the Town Limits and ETJ. The Town received legislative authority in January 2004 to design and adopt ordinances to regulate the removal and preservation of trees within the Town Limits. Staff is currently working on updates to these regulations. This action will be removed from the next update
NRP-4	Encourage Habitat Protection	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town has existing riparian buffer and open space programs which allow for habitat protection. The Town also has additional requirements for areas where there are known threatened or endangered species, i.e., the Town has additional development requirements upstream of SR 1112 to protect the Eastern Tiger Salamander habitat which is negatively impacted by flooding of the pools adjacent to the floodplain. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-5	Discourage Stream Dumping	Flood	Low	Holly Springs Engineering	Local	Completed	The Town adopted the NPDES Phase II Stormwater Illicit Discharge Detection & Elimination Regulations on December 16, 2008 which enforces illicit discharges, illegal connections in or draining to the towns storm drainage system & blockages in watercourses. This action will be removed from the next update
NRP-6	Enforce Wetlands Protection	Flood	Moderate	Holly Springs Engineering, Code Enforcement	Local	Completed	The Town has existing Riparian Buffer, Open Space, and Flood Damage Prevention ordinances that restrict development along streams and in the floodplain thus restricting development in much of the Town's wetland areas. Engineering Design Standards require that all impacts to wetlands be permitted by the US Army Corps of Engineers and the NC DENR Division of Water Quality prior to issuance of a Land Disturbance Permit. The Town also has an existing program that ensures that structures, through review of the Building Permit application, are not constructed in the wetlands unless permitted by the appropriate Federal and State Agencies. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Structural Projects							
SP-1	Implement Channel Maintenance	Flood	High	Holly Springs Public Works	Local	Completed	The Town currently maintains all channels and culverts located within public right-of-way. These channels are inspected and maintained as needed to prevent failure or blockages. This action will be removed from the next update
SP-2	Implement Channel Modifications.	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town modifies channels through the construction of various road projects and ensures through the design that all State and Federal regulations are met. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
SP-3	Implement Channel Modifications & Maintenance	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town's drainage policies and Section 8 of the Engineering Design & Construction Standards include provisions not to maintain or modify drainage features on private property. With the design of a comprehensive stormwater management program the Town may consider changing Town Policy and set up a Stormwater Utility to undertake channel maintenance and modification projects on private property. In areas where there is finished floor flooding after Town Board approval the Town may assist residents in obtaining grant funding for stream restoration projects from available funding sources where the municipality must be the applicant for a project of that nature to be undertaken. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
SP-4	Implement Channel Modifications	Flood	Low	Holly Springs Engineering	Local	Deleted	Incorporated with S-3 above- The Town's drainage policies and Section 8 of the Engineering Design & Construction Standards include provisions not to maintain or modify drainage features on private property. In areas where there is finished floor flooding after Town Board approval the Town may assist residents in obtaining grant funding for stream restoration projects from available funding sources where the municipality must be the applicant for a project of that nature to be undertaken.
SP-5	Install Reservoirs/Retention/Detention Basins	Flood	Moderate	Holly Springs Parks & Recreation	Local	Completed	The Town does not currently maintain any retention or detention basins. The Town does maintain Bass Lake Dam. The Town regularly provides maintenance of vegetation and minor erosion while providing visual inspections of the dam. If larger repairs are required the Town will find appropriate means to resolve the problem. The Town also has a few small ponds located on existing parks. The Town maintains these ponds consistent with measures taken to maintain the Bass Lake Dam. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
SP-6	GPS Project to identify stormwater issues	All	Moderate	Holly Springs Engineering	Local	Completed	The Town locates and maps the sanitary sewer and water systems with GPS. The Town is currently in the process of locating points on stormwater outfalls. New development must also tie their sites into this system. GIS project is updated with new development. This action will be removed from the next update
Emergency Services							
ES-1	Tracking of Known Drainage, Erosion and Flooding Problems	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town has a current program to track drainage complaints, flooding and erosion problems within the town limits and ETJ. The Town maintains a complaint log, map of problem areas and photos to monitor the problem over time. The Town has also developed an inter-departmental office procedure for the Engineering Department to address Hurricane/Storm Preparation – Disaster to assist in the coordination between departments after an event, document flood & erosion and provide opportunity to revise the process for future events. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-2	Identification of Unsafe Structures	All	High	Holly Springs Code Enforcement	Local Federal	Completed	The Town has a continuing program which identifies unsafe structures after instances where damage to the structures could take place, e.g., strong winds or flooding. This action will be removed from the next update
ES-3	Backup Power to Fire and Police Stations	All	High	Holly Springs Public Safety	Local Federal	Completed	The Town provides backup power to all fire and police stations. Fire Station 1 – backup power provided by a grant; backup power to Fire Station 2 and Fire Station 3 and Police Station provided by local funds.
ES-4	Keep Technical Rescue Capabilities updated	All	High	Holly Springs Public Safety	Local Federal	2019	Regional technical rescue teams in place. We have automatic aid in place for their use. However, technical rescue capabilities could be improved with further funding and staff.
ES-5	Carry out After Action Report.	All	High	Holly Springs Public Safety	Local	Completed	The HSFD conducts after-action briefings and reports for all significant incidents. This action will be removed from the next update
ES-6	Develop Standard Operating Guidelines	All	High	Holly Springs Public Safety	Local	Completed	SOGs were implemented in 2014 and will remain in effect going forward. This action will be removed from the next update
ES-7	Utilize GIS Programming to address hazards	All	Low	Holly Springs Public Safety	Local	2018	No current implementation plan in place. The town will look to develop this going forward.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-8	Have Urban Search and Rescue available	All	High	Holly Springs Public Safety	Local	2015	The Town currently has US&R services provided through the NC US&R team region 4, with backup assistance provided by region 8. Internally, we provide urban search and rescue services consisting of structural collapse and similar emergencies. .We will continue the use of NC US&R Teams. We currently do not have enough staffing and equipment to handle this on our own. We are looking at the possibility of moving to an intermediate level of training. Implementation goal 2015
ES-9	Purchase Warning Systems	All	High	Holly Springs Public Safety	Local, State	Deleted	The Town currently uses Wake County's warning systems.
ES-10	Purchase Warning Barricades	All	High	Holly Springs Public Safety	Local	Deleted	The Town uses visual warning barricades for vehicular and pedestrian traffic to block properties, roadways, etc. for the safety of the general public.
ES-11	Purchase Trailer Transportation.	All	high	Holly Springs Public Safety	Local	Deleted	Deploy step van and tandem axel trailers for transportation of emergency barricades and other equipment on a large scale.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-12	ECC Notifications by NOAA for possible severe weather (tornados, ice, etc.).	All	High	Holly Springs Public Safety	local	2017	ECC is notified by both agencies when weather alerts are issued. Information is then broadcast over police radios. This information is generated by the State and Wake County and is obtained through the use of DC message, radio, fax and Nextel. This is in place. The information flow needs some work. There were discussions on utilization of WEB EOC, not sure where implementation of that is.
ES-13	Purchase ACU 1000 Communications Unit	All	High	Holly Springs Public Safety	Local	Deleted	This action has been deleted due to infeasbility
ES-14	Develop Water Emergency Response Plan	All	High	Holly Springs Public Utilities, Engineering	local	Completed	Secondary water sources available during an emergency. A plan has been developed. This action will be removed from the next update
ES-15	Implement Tabletop Exercise Program	All	High	Holly Springs Public Safety	N/A	Completed	Tabletop exercises are held through public safety periodically and will continue to be done. This action will be removed from the next update
ES-16	Emergency Response Plans for the Police Station	All	High	Holly Springs Public Safety	Local	Completed	An emergency response plan is in place and will continue to be evaluated. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-17	Install Emergency Generator	All	Moderate	Holly Springs Public Works	Local	2018	The Town currently has an emergency generator to provide power to the Front Office of the Public Works Building during emergencies. Future goal is to provide 100% generator power to the building.
ES-18	Install additional Generators	All	High	Holly Springs Public Utilities	Local	2019	The wastewater treatment plant and sewer lift stations built after 1994 have generators. In emergency situations, the Town also has mobile generators to be used at lift stations built between 1985 – 1994 that are without permanent generators on site. Over the next ten years, the Town would like to purchase generators for lift stations that do not currently have generators.
ES-19	Mobile Command Post-Available 24 hours a day	All	High	Holly Springs Public Safety	Local State	Completed	Available 24 hours a day and equipped to communicate with all agencies in the Triangle including Emergency Management, State agencies, fire departments, etc .Partial availability and access to Wake EM Command Post This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-20	Drought Preparedness	All	High	Holly Springs Engineering, Public Utilities	Local	Completed	The Town has a drought preparedness and response program that includes conservation regulations, enforcement programs, and preliminary arrangements for alternate sources of water supply. This action will be removed from the next update
ES-21	Develop Emergency Response Plans	All	High	Holly Springs Public Safety	Local	Completed	Emergency response plans are all designed for officers to be assigned for security purposes until owners can take over the responsibility of securing premises. This action will be removed from the next update
ES-22	Adopt Mutual Aid	All	High	Holly Springs Public Works	Local	Completed	The Town of Holly Springs participates in NC water and sewer utilities mutual aid provision and system development. This action will be removed from the next update
ES-23	Implement Sewer Bypasses/Overflows	All	High	Holly Springs Public Utilities	Local	Completed	The Town has a wastewater flow equalization facility at the wastewater treatment plant to prevent sewer bypasses and sanitary sewer overflows in high flow events. Berms have also been installed around the water treatment plant and some of the sewer lift stations. The goal is to put berms around all lift stations as funds are acquired. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-24	Provide Counseling	All	High	Holly Springs Public Safety	Local	Completed	Police psychologist and Critical Incident Stress Debriefing Team training to provide debriefing sessions for personnel. This action will be removed from the next update
Public Education and Awareness							
PEA-1	Disseminate Environmental Education	Flood	High	Holly Springs Engineering	Local	Completed	The Town currently has a program which includes environmental education for the public through Town festivals (Holly Fest), public meetings, brochures and preconstruction meetings. The Town operates the Bass Lake Retreat Center which will allow for space to hold additional environmental education activities. The Town will also expand its current education activities to meet NPDES Phase II requirements. The Town's Environmental Education focuses on flooding, drainage, the National Flood Insurance Program, NPDES Phase II, Erosion & Sedimentation Control, Habitat Preservation, etc. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-2	Disseminate Map Information	Flood	High	Holly Springs Engineering Planning & Zoning	Local	Completed	The Town maintains current FIRM maps and studies for the Town limits and ETJ. The Town also maintains all current land use, structure and development maps. All maps are available for the public use. This action will be removed from the next update
PEA-3	Develop Website	All	High	Holly Springs Governing Body	Local	2017	The Town maintains its own website which is able to provide up to date information for the public. The Town is continuously updating the site with additional resources. This action will be carried over as updates will need to be made to website.

Town of Knightdale Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Adopt Hazard Mitigation Plan & Updates.	All	High	Knightdale Town Council	Internal, HGMP	Upon approval by FEMA	Town Council adopted Plan Update by resolution on 8/19/2009. This update to be adopted pending approval.
P-2	Prepare Plan Maintenance Report.	All	High	Knightdale Planning	Internal	2015, Annually and update	Plan maintenance meetings have been held three of the five years since the last update.
P-3	Prepare updates to Plan.	All	High	Knightdale Planning & Advisory Committee	Internal	2015, Annually and update	No updates have been found necessary to make outside the 5-year update process.
P-4	Revise Hazard Mitigation Plan.	All	High	Knightdale Planning & Advisory Committee	Internal	2014, Every 5 years	Knightdale is actively participating in the county-led process to consolidate all Wake County jurisdictional plans.
P-5	Keep evacuation routes open.	All	High	Knightdale Public Works &Public Safety	Internal	Completed	Knightdale Public Works crews coordinate work with NCDOT and have spread salt and brine and plowed streets during winter storms, and Public Safety personnel keep traffic moving around temporary hazards and through temporarily unsignalled intersections. This action will be removed in the next update as a capability.
P-6	Maintain water supply system, including generators at booster plant	All	High	City of Raleigh Public Utilities	Internal	Completed	City of Raleigh Public Utility crews provide system maintenance per routine schedules. This action will be removed in the next update as a capability. Verify

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-7	Maintain sewer lift stations, including generators.	All	High	City of Raleigh Public Utilities	Internal	Completed	City of Raleigh Public Utility crews provide system maintenance per routine Verify schedules. This action will be removed in the next update as a capability..
P-8	Update Emergency Response Plan.	All	High	Knightdale Public Safety	Internal	2019	Completed, The most recent version of the Knightdale EOP was adopted by the Town Council on March 4, 2013. The town will need to review and update the EOP going forward so this action will remain in the plan.
P-9	Enforce UDO standards for development in flood hazard areas.	Flood	High	Knightdale Planning and Inspections	Internal	Completed	Knightdale Planning Department staff enforces these standards as part of the regular development approval process. This action will be removed in the next update as a capability.
P-10	Prohibit development less than two (2) feet above BFE.	Flood	High	Knightdale Planning	Internal	Completed	Knightdale Planning Department staff enforces this standard as part of the regular development approval process and permit checklists. This action will be removed in the next update as a capability.
P-11	Complete stormwater management plan and institute stormwater management program.	Flood	High	Knightdale Public Works and Engineering	Internal, FEMA, NCEM	Completed	Completed. Knightdale's Phase II permit was renewed on 12/1/2011. Budget and stormwater utility billing were instituted on July 1, 2012.
P-12	Pursue Grants to Acquire, Elevate and or Relocate Flood Prone Structures and Property.	Flood	High	Knightdale Planning	Internal	As needed when funding is available, 2019	This has not been necessary sine there have been no affected structures and/or property.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-13	Require floodproofing and/or removal of structures requesting substantial improvement.	Flood	High	Knightdale Planning and Inspections	Internal	Completed	Revised. This has not been necessary since there have been no requests, but the Town Engineer monitors this through the Town's floodplain development permitting process and inspects property prior to issuance of a CO. This action will be removed in the next update as a capability.
P-14	Maintain list of all structures located within the floodplain.	Flood	High	Knightdale Planning	Internal	Completed	Completed. As of February 2012, the Town maintains the FEMA floodplain maps and impervious surface areas such as building footprints within its GIS system.
P-15	Require burial of power lines for new developments.	Hurricanes, Tornadoes, Winter Storms/ Freezes	Moderate	Knightdale Planning	Private	Completed	Per the Town's UDO, power lines along new streets are required to be placed underground. This standard is enforced through development review and permitting processes. This action will be removed in the next update as a capability.
P-16	Require new construction to comply with wind section of Building Code.	Hurricanes, Tornadoes	High	Knightdale Inspections	Internal	Completed	Inspectors for Knightdale require compliance with the Code through the building permit process. This action will be removed in the next update as a capability.
P-17	Establish post-disaster clean-up procedures.	Hurricanes, Tornadoes, Winter Storms/ Freezes	High	Knightdale Public Works	Internal	Fall 2014	In progress. Rather than set up its own procedures, Knightdale is working with Wake County to piggyback on theirs, and it is expected to be finalized sometime during Spring 2014.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-18	Prepare debris removal and disposal plan.	Hurricanes, Tornadoes, Winter Storms/ Freezes	Moderate	Knightdale Public Works	Internal, FEMA, NCEM	Fall 2014	In progress. Public Works employees and temporarily contracted workers currently oversee debris removal and disposal. This will also be part of the joint procedures and plans with Wake County that will be finalized during Spring 2014.
P-19	Complete the Dempsey E. Benton Water Treatment Plant.	Drought	High	City of Raleigh Public Utilities	Internal	Completed	Completed. City of Raleigh Public Utilities completed and opened the Benton WTP in May 2010.
P-20	Protect and Obtain Land for the Little River Reservoir.	Drought	Moderate	City of Raleigh Public Utilities	Internal	2019	In progress. City of Raleigh has completed the purchase of land necessary for the future construction of the reservoir but the reservoir has not been built.
Public Education and Awareness							
PEA-1	Distribute "Ready Wake" brochures in libraries, Town Hall, public places and on the Town Web Site.	All	Moderate	Knightdale Communications Director	Internal	2015	Knightdale hired a Communications Director in 2013 to oversee these efforts. That office monitors brochure availability with assistance from Parks and Recreation Department and will work to distribute public information via a number of channels.
PEA-2	Inform public of construction requirements in hazard areas.	All	Moderate	Knightdale Building/ Inspections	Internal	Completed	Brochures are maintained and made available to the public and clients are advised by inspectors during the building permit process. This action will be removed in the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-3	Require disclosure of flood hazard in real estate transactions.	Flood	Moderate	Knightdale Planning	Internal	Completed	Planning staff ensure flood hazards are shown on recorded plats through the development review process and permitting checklists. This action will be removed in the next update as a capability.
PEA-4	Present Plan at public meeting.	All	Moderate	Knightdale Planning	Internal, HMGP	2014	In progress. There has been no plan update to present since 2009; however, updates will be presented as part of the new updates process in 2014.
PEA-5	Post plan maintenance report for public comment.	All	Moderate	Knightdale Communications Director	Internal	Completed	Knightdale hired a Communications Director in 2013 to oversee these efforts. To date, no formal reports have been produced from the three update meetings due to lack of significant updates. This action will be removed in the next update as a capability.
PEA-6	Post copy of Plan on website, in Town Hall.	All	Moderate	Knightdale Communications Director	Internal	Upon approval by FEMA	Knightdale hired a Communications Director in 2013 to oversee these efforts; however, the Planning Department posted the 2009 plan to the Town website following its adoption on 8/19/09. This action will be removed in the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-7	Monitor areas known to flood. Directly contact affected property owners by phone or in person.	Flood	Low	Knightdale Engineering and Public Works	Internal	Completed	Engineering and Public Works staff monitor stormwater channels following locally significant events and make needed improvements via the new stormwater utility fund. This action will be removed in the next update as a capability.
PEA-8	Make flood maps available to the public.	Flood	Moderate	Knightdale Planning	Internal	Completed	Knightdale Planning staff work with Wake County and City of Raleigh GIS departments to make maps available through the online "iMaps" application. Planning staff also maintain printed copies for local public inspection. This action will be removed in the next update as a capability.
PEA-9	Distribute "Ready Wake" storm preparation brochures and post on the Town website.	Hurricane	Low	Knightdale Administration	Internal	Deleted	Deleted. Duplicate of PEA-1.
PEA-10	Utilize electronic newsletter to keep citizens informed.	All	Low	Knightdale Communications Director	Internal	2015	Knightdale hired a Communications Director in 2013 to oversee these efforts. The Town's new website Content Management System has various mass communication methods including email blasts and emergency information pop-ups.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-11	Keep website updated with latest storm and emergency response information.	All	Low	Knightdale Communications Director	Internal	Completed	Knightdale hired a Communications Director in 2013 to oversee these efforts. The Town's new website Content Management System has various mass communication methods including email blasts and emergency information pop-ups. This action will be removed in the next update as a capability.
PEA-12	Keep website updated with latest information on drought, water restrictions and water conservation techniques.	Drought	Low	Knightdale Communications Director	Internal	Completed	Knightdale hired a Communications Director in 2013 to oversee these efforts. The Town's new website Content Management System has various mass communication methods including email blasts and emergency information pop-ups. This action will be removed in the next update as a capability.
PEA-13	Develop a policy for the installation of warning signs concerning lightning, hail and thunderstorms at outdoor public facilities and begin retro-fitting existing spaces.	Hail and Lightning	Moderate	Knightdale Parks & Recreation	Internal	2017 – Adopt Policy 2020 – Complete retrofit of existing facilities	New strategy.
PEA-14	Improve drought monitoring and communication of data to the public by relying less on state and regional data and establishing a local source.	Drought	Low	Knightdale Communications Director	Internal, Grants, Local TV Partnership	2019 – Install local weather gauges near Town Hall 2020 – Make daily readings available to the public	New strategy.
PEA-15	Expand the Town's existing fire/smoke alarm program for retro-fitting older structures to include CO alarms.	Winter Storms/ Freezes	Low	Knightdale Fire	Internal, Grants	2016 – Update program guidelines, alarm specifications and policies	New strategy.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-16	Have a Town staff member that is a Certified Floodplain Manager.	Flood	Moderate	Knightdale Engineering/Public Works	Internal	2018 – Staff member certified	New strategy.
PEA-17	Issue an annual local proclamation for Severe Weather Awareness Week and conduct associated promotional activities.	All	Moderate	Knightdale Fire	Internal	March, 2016 – Hold first annual event	New strategy.
PEA-18	Incentivize the use of cool roofing products through the Town's Water Allocation Policy point system.	Extreme Heat	Low	Knightdale Planning	Internal	2017 – Establish appropriate level of incentive within policy	New strategy.
PEA-19	Update current approved plant list to add emphasis on drought tolerant species.	Drought	Moderate	Knightdale Planning	Internal	2016 – New plant list made available	New strategy.

Town of Morrisville Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Improve road visibility and safety by evaluating existing road conditions and paving and/or placing new reflector tape or paint along road edges and in the divided line on all major Town roads.	Flooding, Hurricane, Tornado/ Thunderstorm	Low	Morrisville Director of Public Works	Morrisville Director of Public Works	2016	The town hires an outside firm to perform a Pavement Condition Report on all Town roads every two years. Deficiencies are recorded, and a prioritized schedule on needed repairs is documented.
P-2	Evaluate and update the Town of Morrisville Multi-Hazard Emergency Response Plan on an annual basis.	All	Low	Morrisville Director of Community Services	Morrisville Director of Community Services	2015, Annually	No updates were required in 2013. The town will continue to annually update and review this plan in the future.
P-3	Monitor trees and branches in public areas at risk of breaking or falling in wind, ice, and snow storms. Prune or thin trees or branches when they would pose an immediate threat to property or other significant structures or critical facilities in the Town.	Hurricanes, Tornado/ Thunderstorm, Severe Winter Weather	Moderate	Morrisville Director of Public Works	Morrisville Director of Public Works	Completed	The Town's Public Works Department regularly inspects Town parks, grounds and right of ways for hazardous trees and/or limbs. If trees or limbs have the potential of causing harm or property damage they are removed. Public Works performs approximately four inspections annually. This action will be removed from the next update.
P-4	Maintain all tax parcel information, floodplain locations and frequent flooding areas in Geographic Information Systems (GIS).	Hurricanes, Tornado/Thunderstorms, Flood	Low	Morrisville Senior Planner/Mapping Specialist, Civil Engineer	Morrisville Senior Planner/Mapping Specialist, Civil Engineer	2015, annual review and update	Tax parcel information and floodplain maps have been maintained, and no new flood areas have been identified. Current funding for this policy is adequate. This information will need to be updated on an annual basis.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-5	Evaluate and update the current floodplain ordinances and policies.	Flood	High	Morrisville Planning Director, Town Engineer	Morrisville Planning Director, Town Engineer	Completed	The Town's floodplain management ordinance was integrated in the Unified Development Ordinance (UDO), which was adopted December 10, 2013 with an effective date of July 1, 2014.
P-6	Develop a Debris Management Plan, in conjunction with Wake County's Debris Management Plan, to address debris associated with natural hazards.	All	Moderate	Morrisville Director of Community Services, Director of Public Works	Morrisville Director of Community Services, Director of Public Works	Completed	A Debris Management Plan was developed in 2010. This policy is complete.
P-7	Explore amending the Zoning and/or Subdivisions Ordinances to require all utilities to be placed underground for all new projects and major amendments to existing projects.	Hurricanes, Tornado/ Thunderstorm, Severe Winter Weather	Moderate	Morrisville Planning Director	Morrisville Planning Director	Completed	The Unified Development Ordinance (UDO), which was adopted December 10, 2013 with an effective date of July 1, 2014, requires all new developments to install electric distribution feeder lines and all other utility lines located on the development site and/or along the public right-of-way abutting the site to be installed underground (Section 5.11.B.2, Underground Installation of Required in the UDO). This policy has been met.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Property Protection							
PP-1	Evaluate the need and the cost of purchasing records protection services for information technology related services.	Flooding, Hurricanes, Tornado/ Thunderstorm, Wild-fire	Low	Morrisville Director of Information Technology	General Fund	Completed	A full tape backup of all data from all servers is captured every Sunday night. Each subsequent night, any data that has changed is also backed up to tape. Tapes are stored in a fire proof safe in the Town Hall server room, and additional sets are secured off-site with Iron Mountain. This action will be removed from the next update.
PP-2	Seek Federal, State, and County funding opportunities to purchase property located completely or partially in FEMA designated floodplains in order to mitigate potential property damage and protect natural resources.	Hurricanes, Flooding, Tornado/ Thunderstorm	Low	Morrisville Director of Community Services, Director of Development Services	Federal, State and County Funds	2018	The Town has not sought Federal, State, or Wake County funding to purchase property or land that is completely or partially located in FEMA designated floodplain. The town will look to implement this action in the future where funding allows.
Natural Resource Protection							
NRP-1	Explore the possibility of promoting or requiring xeriscaping as a water conservation measure.	Drought/Heat Wave	Low	Morrisville Planning Director	General Fund	Completed	The Unified Development Ordinance (UDO), which was adopted December 10, 2013 with an effective date of July 1, 2014, encourages the use of drought-tolerant vegetation native to the Morrisville. This policy has been met.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-2	Evaluate expanding the riparian buffer from 50 to 100 feet.	Hurricanes, Flooding, Tornado/Thunderstorm	Low	Morrisville Planning Director	General Fund	Completed	The Unified Development Ordinance (UDO), which was adopted December 10, 2013 with an effective date of July 1, 2014, allows development to occur in a manner that meets the intent of this Ordinance, yet through an alternative design that does not strictly adhere to the Ordinance's design standards.
Structural Projects							
SP-1							
Emergency Services							
ES-1	Monitor the status of backup generators, communications and vehicles for all Morrisville owned critical public facilities. Test generators, communications equipment and vehicles on a regular basis, not only for maintenance, but to confirm that the equipment continues to match the needs of critical facility expansion or updated operations. Purchase and repair equipment as necessary.	All	Low	Morrisville Director of Public Works, Fire Chief, Police Chief	Part of normal town duties, General Fund	Completed	To ensure critical public facilities are able to respond during a disaster, the Town tested generators a minimum of once a month and provided bi-annual maintenance and load tests. Town emergency communication equipment and vehicles are used and maintained year round. The Director of Information Technology should likely be removed as a responsible party during the next 5-year update process.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Public Education and Awareness							
PEA-1	Disperse via the Morrisville Connection newsletter a posting which provides information regarding natural hazard emergency response and preparedness actions the public can take.	Drought/Heat Wave, Flood, Hurricane, Severe Winter Weather	Low	Morrisville Public Information Officer	Part of normal town duties, General Fund	2019	ReadyWake! Emergency Notification System - We informed our residents that we switched to ReadyWake as our emergency notification system. The article encourages residents to sign up to receive emergency notifications. The town will continue to develop new ways to reach out to the public in the future.
PEA-2	Notify citizens of the public hearing on the Hazard Mitigation Plan annual progress report.	All	Low	Morrisville Planning Director	Part of normal town duties, General Fund	2015, Annually	Staff placed an ad in the News and Observer to notify residents of the public hearing. While the current funding is adequate for this policy, staff recommends changing the notification from a legal ad in the newspaper for annual updates to the Town website, Twitter, Facebook, the Morrisville Connection, and/or other media resources that reach a larger audience.
PEA-3	Continue providing website link to Federal and State Declared Emergencies affecting the Town.	All	Low	Morrisville Public Information Officer	Part of normal town duties, General Fund	During a disaster event	Through 2014, when Federal or State Declared Emergencies are made, the website is updated.
PEA-4	Continue advertising the Town of Cary's Water Conservation and Restriction Plans on the Town website.	Drought/Heat Wave	Low	Morrisville Public Information Officer	Part of normal town duties, General Fund	Completed	The Morrisville Connection, which is available on the Town website, provides information from the Town of Cary.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-5	Continued participation in CodeRED, an automated citizen alert system that notifies the public of pending emergencies and actions necessary to take in response to a particular emergency.	All	Moderate	Morrisville Director of Community Services, Fire Chief	General Fund	Completed	The Town transitioned from CodeRED to ReadyWake! in December 2012. ReadyWake! is offered by Wake County and provides the same function as CodeRED.
PEA-6	Utilize volunteer citizen committees, such as CERT or Public Safety Commit-tee, to educate residents in preparing for natural hazards.	All	Low	Morrisville Fire Chief and Police Chief	General Fund	2016	CERT members received monthly training in 2013. The training topics included general emergency/disaster preparedness and response, along with fire safety. Morrisville had 35 active CERT members is 2013. The town will look to enhance the participation of citizens on CERT in the years to come.

City of Raleigh Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Include annual capital budget for the City for ongoing program of stormwater infrastructure improvements. $23.6 million over 10 years.	Flood	Moderate	Raleigh Public Works	Local	Completed	This item has been completed. The fiscal year 2013-14 stormwater capital improvement plan includes $70,000,000 over 10 years for stormwater infrastructure improvements. This action will be removed from the next update.
P-2	Establish a Lake Preservation Policy that encourages private property owners to preserve existing lakes and ponds, and in certain circumstances provides for public assistance.	Flood	Moderate	Raleigh Public Works	Local	2016	Four lake projects are currently under design and construction is projected to be complete on most of these by 2016. While these projects involve water quality benefits, most of these projects involve dam and spillway upgrades (to a higher design storm frequency) that provide additional protection to downstream areas and to avoid dam failures.
P-3	Develop ongoing multi-year program of detailed basin studies for each watershed in City's jurisdiction. Fifteen basin studies are complete with 10 additional studies budgeted in the capital program. (CRS 410).	Flood	Moderate	Raleigh Public Works	Local	2016	We have broken down the city into three main basins. One basin (Walnut Creek) has been completed with the other two being completed by 2016.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-4	Planning Commission to consider program to develop future conditions floodplain mapping for all FEMA mapped areas (this is already done for non-FEMA mapped areas). The program would consist of a multi-year capital program for mapping for all FEMA streams in the ETJ and consideration of changes to development regulations in these areas. Future conditions would be based on expected development per the Comprehensive Plan and zoning maps.	Flood	Moderate	Raleigh Public Works	Local	2014	Maps have been approved, State will be going public with the maps.
Property Protection							
PP-1	Develop ongoing program designed to utilize Federal grant resources to assist private property owners in relocating existing structures out of flood hazard zones. (CRS 500/510/520)	Flood	Moderate	Raleigh Public Works	Local Federal	2019	The city has been approved for multiple grants and removed these structures from the floodplain. The city will continue to try to secure funding for these types of projects in the future.
PP-2	Develop an ongoing program designed to utilize Federal grant resources to assist private property owners in elevating existing structures located within flood hazard zones. (CRS 510/530)	Flood	Moderate	Raleigh Public Works	Local Federal	2019	The City has applied for grants, but has been unsuccessful in obtaining grant assistance for these type projects. The City also has reserved dollars from the stormwater utility fund to supplement potential grant funding and this funding in the Capital Improvement Program is estimated to average approximately $250,000 per year. The city will continue to try to secure funding for these types of projects in the future.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PP-3	Develop an ongoing program designed to utilize Federal grant resources to assist private property owners in renovating and retrofitting existing structures in flood hazard zones to reduce vulnerability to flooding damage.	Flood	Moderate	Raleigh Public Works	Local Federal	2019	The City has applied for grants, but has been unsuccessful in obtaining grant assistance for these type projects. The City also has reserved dollars from the stormwater utility fund to supplement potential grant funding and this funding in the Capital Improvement Program is estimated to average approximately $250,000 per year. The city will continue to try to secure funding for these types of projects in the future.
PP-4	Continue sewer easement clearing and aerial main inspection/cleaning to prevent and eliminate obstructions and erosion that can lead to infrastructure failure, as required by NCDWQ regulations.	Flood	High	Raleigh Public Works	Local	Completed	Easements are regularly inspected and mowed. The aerial mains are inspected quarterly. This action will be removed in the next update as a capability.
PP-5	Require dedication of floodplain property for greenways upon development of property for residential purposes. (CRS 420)	Flood	Moderate	Raleigh Parks and Recreation	Local	Completed	The city requires dedication of floodplain property for greenways upon development of residential property. This action will be removed in the next update as a capability.
PP-6	Revise Comprehensive Plan to consider expanding greenway corridor widths and additional environmental protections for floodplains. (CRS 420)	Flood	Moderate	Raleigh Parks and Recreation, Public Works, and DCP	Local	Completed	The Comprehensive Plan has been revised to expand greenway corridors and added environmental protections for floodplains. This action will be removed in the next update as a capability.
PP-7	Neuse River Master Plan calls for the use of easements, donor gifts, grants, inter-local agreements, public/private partnerships, wetlands mitigation funds, and leases to protect corridor along the entire Neuse River. (CRS 420)	Flood	Moderate	Raleigh Parks and Recreation	Local	Completed	$1 million in 5-year CIP to develop Horseshoe Farm Park. This action will be removed in the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PP-8	When the City's -initiated annexation areas extra-territorial jurisdiction is expanded, or when areas outside the extra-territorial jurisdiction are annexed into the City, initially zone all 100-year floodplain areas to Conservation Buffer zoning district, which restricts development to very limited uses. (CRS 430LZ)	Flood	Moderate	Raleigh Planning	Local	Completed	This policy is active and in place so this action will be removed in the next update as a capability.
Natural Resource Protection							
NRP-1	Develop local program to enforce Erosion and Sedimentation Control standards. Local sedimentation control program complements state program. Eleven staff positions dedicated to this program.	Flood	High	Raleigh Public Works	Local State	Completed	The sedimentation program has been assessed over the last two years and has resulted in improvements in the inspections process, consistency of inspections, plan reviews, and coordination between plan reviewers and inspectors. This action will be removed in the next update as a capability.
Structural Projects							
SP-1	Management and repair of reservoirs, retention and detention basins	Flood	High	Raleigh Public Works	Local	Completed	Program to implement repairs and replacement of stormwater infrastructure in parks, roadways and other public property has been implemented. This action will be removed from the next update as a capability.
Emergency Services							
ES-1	Provide and enhance technical rescue capabilities more equitably throughout the City.	All	High	Raleigh Fire	Local	2018	Technical rescue capabilities have been enhanced more equitably throughout the city, but the city would like to continue to improve this by expanding resources, so this will be pursued going forward.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-2	Provide after-action report of emergency response to severe weather events in order to improve planning for future disasters.	All	High	Raleigh Fire and Emergency Management	Local	Post Event	The city completes after action reports as soon as possible post-event. This action will be removed in the next update.
ES-3	Maintain a standard operating guideline to direct operational planning prior to anticipated weather emergencies.	All	High	Raleigh Fire and Emergency Management	Local	2015, Annual review and update	The city maintains an SOG that is put into place prior to weather emergencies. This SOG is reviewed and updated annually, so this action will remain in the plan going forward.
ES-4	Design GIS programming capable of providing real-time data to emergency managers and historic data for future emergency response planning.	All	High	Raleigh City Manager and Information Technology	Local	2019	A GIS program that can provide real-time data has been developed, but there is still a great deal of work to be done on the system to make it more useful, so the city will continue to try to advance the system.
ES-5	Provide urban search and rescue services consisting of structural collapse and similar emergencies.	All	High	Raleigh Fire	Local State	Completed	USAR services consist of response to structural collapse and similar emergencies. Training occurs at least annually. This action will be removed from the next update as a capability.
ES-6	Continue Walnut Creek and Swift Creek dam warning systems from Lakes Johnson, Raleigh, Wheeler and Benson to the Neuse River. (CRS 610/630)	Flood	High	Raleigh Public Utilities	Local	Completed	The warning systems for Lakes Benson, Wheeler, Johnson and Raleigh are in service. This action will be removed from the next update as a capability.
ES-7	Deploy semi-tractor with Low-Boy Conex trailers for transportation of emergency barricades and other equipment on a large scale.	All	Moderate	Raleigh Police	Local	Deleted	Delete Conex trailers…these are large storage trailers.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-8	Continued use and testing of USGS automated flood warning system and automated reporting on creeks and rivers, e.g., Crabtree Creek. (CRS 610)	All	High	United States Geological Survey	Federal	Completed	Upon notification of rising creeks and possible flooding, units are sent to check visually every 30 minutes for level readings. Note the USGS stream gage data is now available at 15 minute intervals during floods via telephone or the internet. Stormwater staff routinely provides the Command Center staff this information. USGS tests the system every 6 weeks. If schools become threatened, Wake County School Security implements written evacuation plan. This action will be removed from the next update as a capability.
ES-9	ECC Notifications BY NOAA for possible severe weather (tornados, ice, etc.).	All	High	National Oceanic and Atmospheric Administration	Federal State	Completed	ECC is notified by both agencies when weather alerts are issued. Information then broadcast over police radios. This action will be removed from the next update as a capability.
ES-10	ACU 1000 Communications Unit – Currently being tested. System should allow all agencies on ACU 1000 to communicate using own radios and frequencies.	ALL	Moderate High	Raleigh Police	Local	Completed	First responders now utilize the 800 mhz system and can communicate State-Wide with agencies utilizing that system. The ACU 1000 is also operational and can be used for agencies not on the 800 system. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-11	Develop Water Emergency Response Plan in accordance with EPA mandate with wastewater emergency plan developed voluntarily.	All	High	Raleigh Public Utilities	Local (EPA grant)	Completed	This item was completed in 2003 and updated in 2005. The plans are regularly updated. This action will be removed from the next update as a capability.
ES-12	Continue to conduct disaster tabletop exercise program.	All	Low	Raleigh Public Utilities, Fire, Police, City Manager, Emergency Management, and Public Works	Local	2015, Annual review and update	Tabletop disaster exercises are held regularly and will need to be updated and evaluated to ensure applicability to appropriate hazards. The city will conduct and review exercises on at least an annual basis.
ES-13	Program to install emergency electrical generators at all public utilities facilities. Current focus on redundant generators at critical facilities, second fuel truck and completion of 100% generator coverage in Garner area.	All	High	Raleigh Public Utilities	Local	2017	Emergency electrical generators have been installed at public utilities facilities including wastewater pump stations, water booster pump stations, water treatment plants, and the wastewater treatment plants, except for the pump stations in Wake Forest. Installation of emergency generators at the pump stations in Wake Forest is under way as part of the merger capital improvements plan. Redundant electrical generators have been installed at the critical facilities including the NRWWTP influent pump station, NRWWTP UV disinfection facility, and the Walnut Creek Lift Station

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-14	Critical Security Post Coverage - Certain fixed sites identified for coverage during disasters - water treatment, municipal complex, wastewater treatment, etc.	All	Low	Raleigh Police	Local	Completed	Vulnerable business and offices have been identified and are contacted in the event of rising waters. Duplicate of ES-14, so action is complete and will be removed from next update.
ES-15	Mobile Command Post equipped to communicate with all agencies in the Triangle including Emergency Management, State agencies, fire departments, etc.	All	Moderate	Raleigh Police	Local	Completed	Mobile Command Post is available 24 hours a day and is equipped to communicate with all agencies in the Triangle including Emergency Management, State agencies, fire departments, etc. This action will be removed from the next update as a capability.
ES-16	Develop drought preparedness and response program that includes conservation regulations, enforcement programs, and preliminary arrangements for alternate sources of water supply.	Drought	Moderate	Raleigh Public Utilities	Local	Completed	Water conservation plan and drought response plan are in place. Retention of existing water (swimming pools, newly developed cistern system, and non-potable water containment system) This action will be removed from the next update as a capability.
ES-17	Develop Emergency Response plans for buildings	All	Low	Raleigh Police	Local	Completed	Emergency Response plans are all designed for officers to be assigned for security purposes until owners can take over the responsibility of securing premises. Progress made. Personnel will cover critical locations to the best of our ability. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-18	Participate extensively in NC water and sewer utilities mutual aid provision and system development.	All	Moderate	Raleigh Public Utilities	Local FEMA	Completed	The PUD helped develop and is a member of the NCWARN program (NC Water and wastewater Agency Response Network) with other utilities statewide to provide mutual aid to each other. This action will be removed from the next update as a capability.
ES-19	Counseling	All	Low	Raleigh Police	Local	Completed	Police psychologist and a Critical Incident Stress Debriefing Team training to provide debriefing sessions for personnel. This action will be removed from the next update as a capability.
Public Education and Awareness							
PEA-1	Provide technical assistance to private property owners who are subject to structural flooding.	Flood	Moderate	Raleigh Public Works	Local	Completed	Conservation engineer does site inspection and reports recommendation to reduce flood damage. This action will be removed from the next update as a capability.
PEA-2	Provide flood zone information to any inquirer.	Flood	High	Raleigh Public Works	Local	Completed	Stormwater staff provides flood zone information through call-in or e-mail program to any inquirer. City requires showing flood zone information on all plats recorded in City's jurisdiction. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-3	Environmental Education	Flood	Moderate	Raleigh Public Works	Local	Completed	City maintains a stormwater web site to answer citizen questions about flood hazards, flood safety, availability of flood insurance, and various programs, operates a speakers' bureau and published a 24-page stormwater utility program brochure in 2004. (CRS 330) A Stormwater Public Education position was approved in the 08-09 budget that specifically addresses education needs in the stormwater area. This action will be removed from the next update as a capability.
PEA-4	Develop WaterFest Outreach Program (CRS 360)	All	Low	Raleigh Public Utilities	Local	Completed	Annual event draws up to 6,000 school children, plus teachers and chaperones. Focus on environmental issues, including sewer, stormwater, solid waste management, etc. in late spring. City continues to conduct this event. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-5	Partner with Wake County to utilize the “Communicator” application that will warn property owners of impending flood events. (CRS 610)	Flood	Moderate	Raleigh Information Services and Information Technology	Local	Completed	The City partners with Wake County to utilize the “Communicator” application that utilizes GIS technology to develop automated call lists to warn property owners of impending flood events. (CRS 610) The communicator application is now available for city use. This action will be removed from the next update as a capability.
PEA-6	Institute “Stormwater hotline” (CRS 360)	Flood	Moderate	Raleigh Public Works	Local	Completed	City maintains a stormwater hotline which is answered extended hours during the week. Citizens may report flooding problems, pollution issues, erosion problems, infrastructure damage. City continues to maintain the hotline. This action will be removed from the next update as a capability.
PEA-7	When available, the City will incorporate and use new LIDAR flood maps. Information will be available to the public. (CRS 320/440)	Flood	Moderate	Raleigh Public Works	Local	Completed	New maps have been adopted as the updated FEMA flood insurance rate map. This action will be removed from the next update as a capability.
PEA-8	City will continue to maintain flood elevation certificates and make copies available to the public. (CRS 310/440)	Flood	Moderate	Raleigh Inspections	Local	Completed	City continues to maintain certificates and make copies available to public. This action will be removed from the next update as a capability.
PEA-9	City will continue to update flood hazard maps to reflect new subdivisions, changes in corporate limits, and any new DFIRM data. (CRS 320/440)	Flood	Moderate	Raleigh Public Works, Inspections, and Planning	Local	Completed	City continues to update the maps. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-10	The city will leverage the State of NC Residential Property Disclosure Statement which includes check off on whether or not the property being offered for sale is within a Federally-designated floodplain. (CRS 340)	Flood	Moderate	State of North Carolina	State	Completed	City continues to include the check off for floodplains. This action will be removed from the next update as a capability.
PEA-11	The City will support Wake County efforts to make flood protection educational materials available in all branches of the Wake County public library system. (CRS 350).	Flood	Moderate	Wake County	County	Completed	City continues to supply local libraries with educational information. This action will be removed from the next update as a capability.

Town of Rolesville Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	UDO: Continue to provide stream and creek buffers, and floodplain and wetland protection.	Flood	High	Rolesville Planning	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
P-2	UDO: Resource Conservation Areas (RCA) – Continue to protect floodplains, streams, and creeks.	Flood	High	Rolesville Planning	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
P-3	UDO: Subdivision Standards – Continue to provide protection for residential areas by not allowing residential lots in the floodplain.	Flood	High	Rolesville Planning	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
P-4	UDO – Ensure buildings are minimum 2' above base flood elevation.	Flood	High	Wake County	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
P-5	UDO: Flood Damage Prevention Overlay District – Continue to restrict and prohibit uses which are dangerous to health, safety, and property. Uses vulnerable to floods are protected.	Flood	High	Rolesville Planning	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
P-6	UDO: Flood Damage Prevention – Ensure control is provided for filling, grading and dredging within floodplains by working with necessary State and Federal Agencies.	Flood	Moderate	Rolesville Planning and Town Manager	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
P-7	Ensure road standards maintained in disaster preparation for possible use as evacuation routes.	All	Moderate	Rolesville Planning	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-8	Provide adequate water supply through storage and interconnection with other public water systems.	Drought	Moderate	City of Raleigh	Local	Completed	As of 2014, the City of Raleigh maintains all water and sewer facilities as part of their greater system. This action will be removed in the next update.
P-9	Provide backup power for all critical public facilities (wastewater treatment plant, sewer pump stations, Public Works and Utilities building, and other critical public buildings).	All	Moderate	City of Raleigh	Local	2019	As of 2014, the City of Raleigh maintains all water and sewer facilities as part of their greater system. The town will continue to identify facilities that need backup power
P-10	Maintain major town transportation routes through snow and ice removal contracts and equipment.	Severe Winter Storms	Moderate	Rolesville Administration	Local	Completed	As of 2014, the town maintains standing contracts for snow and ice removal when necessary. This action will be removed in the next update.
P-11	Require Engineered Storm Water Control Structures where necessary.	Flood	Moderate	Rolesville Planning	Local	Completed	Since 2010, the town has partnered with Wake County to adopt a comprehensive storm water ordinance. Wake County reviews all development for compliance. This action will be removed in the next update.
P-12	Town regularly backs-up information pertaining to Town government in case of an emergency.	All	Moderate	Rolesville Town Manager	Local	Completed	As of 2014, the town continues to back up electronic information on a regular basis. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-13	Transportation Plan – Continue to address disaster preparedness (evacuation) through road interconnectivity, paved roads, and widening of roads.	All	Moderate	Rolesville Planning	Local	2017	From 2010 to 2014, several new streets have been built and many others have been resurfaced. Going forward, roads will continue to be evaluated for their use in disaster preparedness and the Transportation Plan will be updated accordingly.
Natural Resource Protection							
NRP-1	UDO: Continue to require engineered stormwater controls including stream and wetland protection.	Flood	Moderate	Local	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
NRP-2	UDO: Flood Damage Prevention Overlay District - continue to prohibit any development in floodway to protect floodplains and wetlands.	Flood	Moderate	Local	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
NRP-3	Develop Open Space Ordinance to protect wildlife habitat.	All	Moderate	Local	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
NRP-4	UDO: Incorporate regulations for illicit discharge control in Phase II Stormwater Management Plan.	Flood	Moderate	Local	Local	Completed	Since 2010, the town has partnered with Wake County to adopt a comprehensive storm water ordinance. Wake County reviews all development for compliance. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-5	UDO -Stream Dumping – Through the NPDES Phase II Stormwater program, the Town will design and implement an illicit discharge program which will enforce regulations against illegal stream dumping.	Flood	Low	Local	Local	Completed	Since 2010, the town has partnered with Wake County to adopt a comprehensive storm water ordinance. Wake County reviews all development for compliance. This action will be removed in the next update.
Emergency Services							
ES-1	Emergency Operations Command Post Center – established when natural hazard is imminent. Center coordinates evacuations, sheltering, staging areas for equipment, manpower, and needed supplies. Equipment includes internet access, telephone, wireless communications, radio and backup supplied by emergency batteries and/or generators.	All	High	Rolesville Town Manager, Fire, EMS, and Police	Local	Completed	As of 2014, the EOCPC is still maintained and operated out of the Rolesville Rural Fire Dept. station as needed. This action will be removed in the next update.
ES-2	Ongoing provision of emergency assistance as needed.	All	High	Rolesville Fire, EMS, and Police	Local	Completed	As of 2014, these actions are ongoing as they occur daily. This action will be removed in the next update.
ES-3	Ensure hazard warning methods include television, radio, internet and, if needed, emergency vehicles with loud speaker systems.	All	Moderate	Rolesville Fire, EMS, and Police	Local	Completed	As of 2014, website, telephone (Reverse 911),and email notifications currently available from the Town. This action will be removed in the next update.
ES-4	Maintain open lines of communication between all branches of emergency response personnel.	All	Moderate	Rolesville Fire, EMS and Police	Local	Completed	As of 2014, these actions are ongoing as they occur daily. This action will be removed in the next update.
ES-5	Prepare for emergency situations – weather station, local weather warning system, and emergency management.	All	Moderate	Rolesville Fire	Local	Completed	As of 2014, these actions are ongoing as they occur daily. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-6	Standard Operating Guidelines – collection of procedures to be followed during emergencies.	All	High	Rolesville Fire	Local	Completed	As of 2014, these actions are ongoing as they occur daily. This action will be removed in the next update.
ES-7	Continue Pre-Fire Incident Plan program for all commercial facilities within the Town limits.	All	High	Rolesville Fire	Local	Completed	As of 2014, these actions are ongoing as they occur daily. This action will be removed in the next update.
ES-8	Maintain contact information for local businesses in case of an emergency.	All	High	Rolesville Fire	Local	Completed	As of 2014, these actions are ongoing as they occur daily. This action will be removed in the next update.
ES-9	Continue to evaluate and improve response and recovery methods following each hazard event.	All	High	Rolesville Fire, Police, and Town Manager	Local	Completed	The town continues to evaluate and improve response and recovery methods as needed. This action will be removed in the next update.
ES-10	Health and safety maintenance – provide assistance with security and post storm clean-up.	All	High	Rolesville Fire, Police, and Town Manager	Local	Completed	As of 2014, assistance is provided as needed. This action will be removed in the next update.
ES-11	Post disaster response – building inspections personnel will respond as needed.	All	Moderate	Wake County	Local	Completed	Wake County inspections will continue to provide personnel and inspections as needed for disaster response. This action will be removed in the next update.
ES-12	Counseling – Police psychologist and Critical Incident Stress Debriefing Team training to provide debriefing sessions for personnel.	All	High	Rolesville Public Safety	Local	Completed	As of 2014, assistance is provided as needed. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Public Education and Awareness							
PEA-1	Town website - develop hazard mitigation section covering such items as public access, evacuation routes, emergency contact numbers, and detailed weather reports in case of emergency,	All	Moderate	Rolesville Adminsitration	Local	2016	Since 2010, the Town's website has been updated substantially to include some, but not all, of these items. The town will work to update the website with other items in the future.
PEA-2	Hazard Disclosure – Maintain geographic information systems (GIS) map to increase public awareness of known hazard locations.	Flood	Moderate	Rolesville Planning	Local	Completed	The Town's GIS library is continually updated with data from Wake County. These updates will continue monthly and as needed. This action will be removed in the next update.
PEA-3	Develop planned park to include nature trails and environmental education center.	Flood	High	Rolesville Town Manager	Local Wake County	2019	As of 2014, Mill Bridge Nature Park (with trails) is open to the public. Funding for the education center has not yet become available.
PEA-4	Town Hall – Maintain and update hazard information accessible to the public.	All	Moderate	Rolesville Planning	Local	2016	As of 2014, a copy of the town's hazard mitigation plan is maintained online as well as hardcopy (at town hall) for public viewing. The town will look to improve public education and information sharing through additional channels.
PEA-5	Continue to provide flood maps for public use with staff continuing to be available for public assistance.	Flood	High	Rolesville Planning	Local	Completed	As of 2014, FIRM maps are available at town hall for review and planning staff are always available for public assistance during regular business hours (8am-5pm M-F). This action will be removed in the next update.

Town of Wake Forest Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Consider preventing all unnecessary development in the flood plains.	Flood	High	Wake Forest Planning	Local	Completed	The town prevents all unnecessary development in the floodplain through regulation. This action will be removed from the next update.
P-2	Examine and modify, if needed, policies and procedures for utility stream crossings.	All	High	Wake Forest Engineering	General Fund	Completed	Through 2014, the town has examined and modified procedures for stream crossings so this action has been completed and will be removed from the next update.
P-3	Prepare a Storm Drainage Master Plan to include all storm drainage, infrastructure, and capacity analysis.	Flood	High	Wake Forest Engineering	General Fund	2017	A Storm Drainage Master Plan has been developed to include drainage, infrastructure and capacity analysis. However, this plan will need to be reviewed and updated going forward so the action will remain in the plan.
P-4	Maintain inventory of dams.	Dam Failure	High	Wake Forest Engineering	General Fund	Completed	An inventory of dams has been built and is updated when necessary. This action will be removed from the next update.
P-5	Maintain clear right-of-ways by removing fallen trees.	Flood, Hurricane, Thunderstorm	High	Wake Forest Power	Electric Fund	Completed	Fallen trees are cleared as quickly as possible so that right of ways can be maintained. This action will be removed from the next update as a capability.
P-6	Ensure that as many electric lines as possible are looped.	Flood, Hurricane, Thunderstorm	High	Wake Forest Power	Electric Fund	Completed	Electric lines are looped whenever possible. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-7	Ensure that underground equipment is installed above the flood plain.	Flood, Hurricane, Thunderstorm	High	Wake Forest Power	Electric Fund	Completed	No development is permitted in floodplains by ordinance. This action will be removed from the next update as a capability.
P-8	Enforce burn bans and the littering ordinance regarding the discarding of cigarette butts during times of drought.	Wildfire	High	Wake Forest Police	General Fund	Completed	Burn bans and the littering ordinance are enforced, especially during drought periods. This action will be removed from the next update as a capability.
P-9	Update annually the hazardous material inventory, as required by law.	Hazardous Materials Incident	High	Wake Forest Inspections and Fire	General Fund, Fire Tax Revenue	Completed	The hazardous material inventory is reviewed and updated annually. This action will be removed from the next update as a capability.
P-10	Add amendments to the hazardous materials inventory as frequently as the information is available.	Hazardous Materials Incident	High	Wake Forest Inspections and Fire	General Fund, Fire Tax Revenue	Completed	Amendments have been added to the inventory very quickly in the past and this will continue to be done in the future. This action will be removed from the next update as a capability.
P-11	Obtain an inventory of hazardous material storage sites within a five mile radius of town.	Hazardous Materials Incident	High	Wake Forest Fire and/or Wake and Franklin Counties	General Fund, Fire Tax Revenue, County	Completed	An inventory of these sites has been obtained. This action will be removed from the next update as a capability.
P-12	Coordinate with Wake County and with the Wake County Plan on nuclear accident planning.	Nuclear	High	Wake Forest Fire and Police	General Fund	Completed	The town regularly coordinates with Wake County on nuclear planning. This action will be removed from the next update as a capability.
P-13	Identify high occupancy areas along US#1 which may be heavily impacted in the event of an accident along the highway.	Nuclear	Moderate	Wake Forest Fire and Police	General Fund	Completed	High occupancy areas along US 1 have been identified. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-14	Cooperate with Wake County Public Safety in developing a Terrorist Response Plan.	Terrorist Threat	High	Wake Forest Fire and Police Coordinator	General Fund	Completed	Wake County has developed a Terrorist Response Plan. This action will be removed from the next update as a capability.
P-15	Identify security issues with utilities.	Terrorist Threat	High	Wake Forest Public Works and Power	General Fund and Electric Fund	Completed	The town has identified high risk utilities and potential security issues. This action will be removed from the next update as a capability.
P-16	Security measures in effect at the new Town Hall, when completed.	Terrorist Threat	High	Wake Forest Town Administration	General Fund	Completed	The town has implemented security measures at the new town hall. This action will be removed from the next update as a capability.
P-17	Review and revise the existing response plan and call list, as needed	All	High	Wake Forest Administration	General Fund	2016	The town has reviewed and revised the existing response list. However, this list will need to be updated in the near future, so this action will remain in the plan.
P-18	Put electric distribution lines underground.	All	Low	Wake Forest Power	Electric Fund and General Fund	2019	Where feasible, electric lines have been put underground. However, there are still some lines that could be buried and the town will look into carrying that out going forward.
P-19	Require, where possible, multiple accessibility routes through proper design of the street layout.	All	High	Wake Forest Planning	General Fund	Completed	Transportation Plan updated to include multiple accessibility in many areas. Plan is being implemented.
P-20	Coordinate with nearby counties, including Franklin and Granville, as well as Wake.	All	High	Wake Forest Fire and Police and Communications	General Fund and Fire Tax Revenue	Completed	The town coordinates across several counties on many planning and EM activities. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-21	Develop a policy for preplanning before an event.	All	High	Wake Forest Public Works, Fire, Police, Administration, and Communications	General Fund and Fire Tax Revenue	Completed	The town has developed a policy for pre-planning prior to an event that coordinates with Wake County. This action will be removed from the next update as a capability.
P-22	Review and revise the existing call list, as needed.	All	High	Wake Forest Administration	General Fund	Deleted	This action has been determined not to be extremely applicable to mitigation so it was deleted
P-23	Adopt and implement a tree trimming and maintenance procedure for power lines.	All	High	Wake Forest Electric, Urban Forestry Board	Electric Fund	Completed	A tree trimming and maintenance policy was developed and is in place. This action will be removed from the next update as a capability.
P-24	Adopt and implement a policy of tree swapping (tall for understory trees under lines).	All	Moderate	Wake Forest Power, Urban Forestry Board	Electric Fund, General Fund	Completed	A policy for tree swapping has also been developed and is in place. This action will be removed from the next update as a capability.
P-25	Adopt a policy to power down before major damage is done and make the public aware of this policy.	All	High	Wake Forest Electric	Electric Fund	Completed	A policy to power down before major events and reduce the risk of major damage has been adopted and implemented. This action will be removed from the next update as a capability.
P-26	Develop and implement a policy to inspect utility poles and replace them, as needed.	All	High	Wake Forest Electric	Electric Fund	Completed	A policy to inspect utility poles prior to events has been adopted and is currently being implemented. This action will be removed from the next update as a capability.
P-27	Review problem areas, determine needs, and set priorities for putting lines underground or for relocating overhead lines.	All	High	Wake Forest Power	Electric Fund	Deleted	Similar to P-18, combine and delete

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-28	Require that new development install underground wiring.	All	High	Wake Forest Planning and Power	General Fund and Electric Fund	Completed	New development is required to install underground wiring. This action will be removed from the next update as a capability.
P-29	Develop policy to include putting lines underground as other town projects are constructed.	All	High	Wake Forest Administration and Power	General Fund and various project grants	Completed	When other town projects are constructed, lines are put underground. This action will be removed from the next update as a capability.
P-30	Implement the water conservation policy.	All	High	Wake Forest Administration and Power	General Fund	Completed	The town follows City of Raleigh Policy for water conservation. This action will be removed from the next update as a capability.
P-31	Prohibit new in-ground irrigation systems that are tapped into the City of Raleigh system.	All	High	Wake Forest Inspections	General Fund	Deleted	This action was determined to not be technically feasible so it was deleted.
Structural Projects							
SP-1	Conduct stream mitigation projects on Old Mill Stream, Richland Creek, and others subject to flooding or erosion.	Erosion	Moderate	Wake Forest Engineering	General Fund, Clean Water Management Trust Fund, Ecosystem Enhancement Program	2019	Some mitigation projects have been conducted on these water bodies, but there is significant effort that is still needed to reduce potential erosion. The town will work to complete more erosion control projects going forward.
Emergency Services							
ES-1	Require lockboxes at hazardous material storage sites for the Fire Dept.	Hazardous Materials Incident	High	Wake Forest Fire	Property owners	Completed	Lockboxes are required at HazMat storage sites. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-2	Forward inventory updates and amendments, along with information on risks and potential hazards, to all emergency response organizations.	Hazardous Materials Incident	High	Wake Forest Emergency Management Coordinator (Police)	General fund	Completed	Inventory updates and other information are forwarded to all emergency response organizations. This action will be removed from the next update as a capability.
ES-3	Coordinate with County school system, local school personnel, including Franklin Academy, and Wake County Public Safety Emergency Management.	All	High	Wake Forest Fire, Police, and Emergency Management Coordinator	General Fund	Completed	The town coordinates with the school system, including private schools, on emergency management issues. This action will be removed from the next update as a capability.
ES-4	Provide for primary or mobile generators to shelter sites.	All	Moderate	Wake County Emergency Management	General Fund	2018	Generators in some form are available to shelter sites. However, additional generators would be useful and will be pursued where possible.
ES-5	Coordinate with suppliers of all basic supplies for shelters.	All	High	Wake Forest Administration and Finance	General Fund	Completed	The town coordinates with suppliers to ensure that all shelters are well-equipped with the necessary supplies. This action will be removed from the next update as a capability.
ES-6	Coordinate with suppliers and develop a resource list for fuel and power generation.	All	High	Wake Forest Finance	General Fund	2016	The town coordinates with suppliers to ensure that all shelters are well-equipped with fuel and power generation. This action will be removed from the next update as a capability.
ES-7	Investigate methods of encouraging gas stations to acquire backup generators.	All	High	Wake Forest Public Works and Inspections	General Fund	2017	The town has looked into ways to encourage gas stations to acquire backup generators. In some cases this has occurred, but more work is needed to ensure adequate supply.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-8	Assess facilities for the need for emergency generation, giving consideration to alternate facility sites.	All	High	Wake Forest Public Works	General Fund	2018	The town has assessed facilities for the need for emergency generation and many facilities have been fitted with generators. However, additional facilities with emergency generation would be useful.
ES-9	Locate generators at necessary facilities, including alternate emergency sites.	All	High	Wake Forest Public Works and Public Buildings	General Fund	Deleted	Similar to ES-8, combine and delete
ES-10	See that all nursing homes and assisted living facilities have backup generators.	All	High	Property owners	Property owners	2018	Although many nursing homes and assisted living facilities have backup generators, this is still a task that remains incomplete so it will remain in the plan.
ES-11	Require, in the contract, that fuel suppliers have backup generators.	All	High	Wake Forest Administration, Finance, and Public Works	Contract holder	2018	Although many fuel suppliers have backup generators, this is still a task that remains incomplete so it will remain in the plan.
ES-12	Develop one or more clearance teams of emergency personnel, coordinating with the Wake Forest Fire Department in this process.	All	High	Wake Forest Fire and Public Works	General Fund and Fire Tax Revenue	Completed	The Fire Department has developed clearance teams to help remove downed trees and other potential debris. This action will be removed from the next update.
ES-13	Train the clearance teams and supply them with chain saws and other emergency equipment.	All	High	Wake Forest Fire and Public Works	General Fund and Fire Tax Revenue	Completed	The Fire Department has trained clearance teams to help remove downed trees and other potential debris. This action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-14	Follow a specified policy on the use of brine, sand, and plowing to reduce the impact of a storm.	Severe Winter Weather	High	Wake Forest Public Works	General Fund	Completed	A policy has been developed to guide the use of brine, sand, and plowing to reduce the impact of winter storms. This action will be removed from the next update.
ES-15	Implement the county-wide 800 trunking system.	All	High	Wake Forest Police	General Fund, Electric Fund	Completed	A county-wide trunking system has been developed and is in place. This action will be removed from the next update.
ES-16	Purchase necessary communication equipment.	All	High	Each department purchases their own	General Fund	Completed	Communication equipment has been purchased and is utilized by each department in the town. This action will be removed from the next update.
ES-17	Train personnel to use communication equipment.	All	High	Wake Forest Administration	General Fund	Completed	Personnel in each department have been trained to use the communication equipment. This action will be removed from the next update.
ES-18	Coordinate with the natural gas company regarding the gas supply and potential hazards after an event.	All	High	Wake Forest Fire and Police	General Fund	Completed	The natural gas company has been coordinated with concerning how to supply gas after a hazard event. This action will be removed from the next update.
Public Education and Awareness							
PEA-1	Develop or revise a procedure for communication with employees and the public, including alternatives if the existing system fails.	All	High	Wake Forest Communication	General Fund	Completed	The town has developed a system for communicating with employees and the public concerning severe weather and alternative means of contact have been developed as well. This action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-2	Inform the public periodically about emergency policies.	All	High	Wake Forest Communications	General Fund	Completed	Done – Town contacts residents on call / email list when emergencies happen. This action will be removed from the next update.
PEA-3	Develop a policy and advise the public that all outside above ground LP or propane gas tanks be cut off during a major event.	All	Moderate	Wake Forest Communications	General Fund	2017	A policy is in place to advise the public of turning off propane tanks during a storm, but better outreach is needed to ensure this occurs. Therefore the town will continue to work on an outreach program.

Town of Wendell Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Prepare Hazard Mitigation Plan Update.	All	High	Wendell Advisory Committee	Internal	Completed	This is in the process currently. This action will be removed from the next update.
P-2	Prepare Multi-Jurisdictional Hazard Mitigation Plan.	All	High	Atkins and Participating Jurisdictions	Wake County Grant	August 2014	This is in the process currently. This action will be removed from the next update.
P-3	Adopt Hazard Mitigation Plan Update.	All	High	Wendell Town Board of Commissioners	Internal	Upon approval of Hazard Mitigation Plan by FEMA	Upon 2014 approval of Hazard Mitigation Plan by FEMA. This is in the process currently. This action will be removed from the next update.
P-4	Prepare Plan Maintenance Report.	All	High	Wendell Planning	Internal	Annually	This action will be removed from the next update as it is done annually.
P-5	Prepare updates to Plan.	All	High	Wendell Planning	Internal	As needed	This is in the process currently. This action will be removed from the next update.
P-6	Revise Hazard Mitigation Plan.	All	High	Wendell Advisory Committee	Internal	Every five years	Town is participating in Multi-jurisdictional HMP. This is in the process currently. This action will be removed from the next update.
P-7	Keep evacuation routes open.	All	High	Wendell Public Works and Public Safety	Internal	Completed	Evacuation routes have been established and are maintained. This is in the process currently. This action will be removed from the next update.
P-8	Maintain trees adjacent to power lines and critical facilities.	All	High	Wendell Public Works and Progress Energy	Internal and Private	Completed	Trees adjacent to power lines and critical facilities have been maintained and will continue to be monitored. This is in the process currently. This action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-9	Maintain water supply system.	All	High	City of Raleigh Public Utilities	Internal	Completed	City of Raleigh Public Utility crews provide system maintenance per routine schedules. This action will be removed in the next update as a capability.
P-10	Maintain sewer lift stations, including generators.	All	High	City of Raleigh Public Utilities	Internal	Completed	City of Raleigh Public Utility crews provide system maintenance per routine schedules. This action will be removed in the next update as a capability.
P-11	Install generators as needed at lift stations.	All	High	City of Raleigh Public Utilities	Internal	2019	Generators have been installed at several lift stations, but more may be necessary looking forward. This will be evaluated and additions will be made as deemed appropriate.
P-12	Maintain Storm Drainage system.	Flood	High	Wendell Public Works	Internal	Completed	The storm drainage system is maintained. This action will be removed in the next update as a capability.
P-13	Enforce subdivision standards for development in flood hazard areas.	Flood	High	Wendell Planning and Inspections	Internal	Completed	Subdivision standards restricting development in the floodplain are in force. This action will be removed in the next update as a capability.
P-14	Further restrict development in floodplain by prohibiting development.	Flood	High	Wendell Planning	Internal	Completed	Development is prohibited in the floodplain. Implemented through UDO. This action will be removed in the next update as a capability.
P-15	Require burial of power lines for new developments.	Hurricanes, Tornadoes, Winter Storms/ Freezes	Moderate	Wendell Planning	Private	Completed	A requirement for burying power lines is in place. This action will be removed in the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-16	Require new construction to comply with wind section of Building Code.	Hurricanes, Tornadoes	High	Wendell Inspections	Internal	Completed	New construction must comply with the wind section of the building code. This action will be removed in the next update as a capability.
P-17	Include flood map data on GIS system.	All	Moderate	Wendell Planning	Internal	2019	Flood map data is included on the GIS system. However, this data will need to be updated as new flood information is made available.
Natural Resource Protection							
NRP-1	Maintain and expand greenway system, stream buffers.	Flood	Low	Wendell Parks and Recreation	Internal, Private Developers	2018	Seeking funding and easements started in 2013. This action has begun, but it is not yet completed.
Emergency Services							
ES-1	Implement Disaster Notification Policy.	All	High	Wendell Public Safety	Internal	Completed	This policy has been implemented. This action will be removed in the next update as a capability.
ES-2	Adhere to Disaster Notification Policy.	All	High	Wendell Public Safety	Internal	Completed	This policy has been implemented. This action will be removed in the next update as a capability.
ES-3	Implement Community Center Use Policy.	All	High	Wendell Parks and Recreation	Internal	Completed	This policy has been implemented. This action will be removed in the next update as a capability.
ES-4	Adhere to Community Center Use Policy.	All	High	Wendell Parks and Recreation	Internal	Completed	This policy has been implemented. This action will be removed in the next update as a capability.
ES-5	Review Inclement Weather Policy.	All	High	Wendell All Departments	Internal	2018	The Inclement Weather Policy is in place and will continue to be utilized. However, the policy will need to be reviewed and updated.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-6	Adhere to Snow and Debris Removal Policy.	Hurricanes, Tornadoes, Winter Storms/ Freezes	High	Wendell Administration and Public Works	Internal	Completed	This policy has been implemented. This action will be removed in the next update as a capability.
ES-7	Adhere to debris removal and disposal plan.	Hurricanes, Tornadoes, Severe Winter Storms	Moderate	Wendell Administration and Public Works	Internal and Possible Grant	Completed	This policy has been implemented. This action will be removed in the next update as a capability.
Public Education and Awareness							
PEA-1	Provide links to hazard notices on Town website.	All	Moderate	Wendell Town Web Administrator	Internal	Completed	Hazard notices are posted on the town website when events occur. This will continue going forward.
PEA-2	Inform public of construction requirements in hazard areas.	Flood	Moderate	Wendell Building, Inspections	Internal	2015	Materials have been developed to inform the public of construction requirements in hazard areas, but this material requires updating.
PEA-3	Require disclosure of flood hazard in real estate transactions.	Flood	Moderate	Wendell Planning	Internal	Deleted	Delete – not feasible to be involved in real estate transactions
PEA-4	Make FEMA manuals available to residents.	All	Moderate	Wendell Planning	Internal	2015, annual review and update	FEMA manuals have been made available to residents in the past, but new materials are consistently being developed so the town will need to review and update materials annually.
PEA-5	Present Plan at public meeting.	All	Moderate	Wendell Planning	Internal	Completed	Complete New Target Date September 2014. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-6	Post plan maintenance report for public comment.	All	Moderate	Wendell Town Manager	Internal	Completed	Plan maintenance report was posted for viewing by the public. This action will be removed in the next update.
PEA-7	Post copy of approved Plan in Town Hall.	All	Moderate	Wendell Planning	Internal	Completed	A copy of the plan was posted at Town Hall. This will be done with the new plan update as well. This action will be removed in the next update.
PEA-8	Provide links to flood warnings, hurricane tracks, tornado and severe thunderstorm warnings, winter storm warnings, and drought/heat wave information on website.	Flood, Hurricane and Tropical Storms, Tornadoes, Severe Thunderstorm, Drought, Heat Wave	Low	Wendell Town Web Administrator	Internal	2018	Links are provided on the website for these items but will need to be updated.
PEA-9	Make flood maps available to the public.	Flood	Moderate	Wendell Planning	Internal	Completed	Flood maps are available to the public via a number of channels. This action will be removed in the next update.
PEA-10	Post water restrictions and tips for reducing water consumption on website, within Town Hall, and on local access television station.	Drought/Heat Wave	Moderate	Wendell Public Works	Internal	Completed	Tips on water restrictions and for reducing consumption have been displayed online. This action will be removed in the next update.
PEA-11	Keep website updated with latest storm and emergency response information.	All	Low	Wendell Web Administrator	Internal	Completed	The town has website updated and available to keep public informed in case of emergencies

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-12	Inform public about flood mitigation techniques (i.e., remove debris from storm drains prior to large storm event).	Flood, Hurricane and Tropical Storms, Severe Thunderstorm	Moderate	Wendell Public Works	Internal	2017	New action

Town of Zebulon Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Prepare Hazard Mitigation Plan Update.	All	High	Zebulon Advisory Committee	Town of Zebulon	2014, Every 5 years	The Hazard Mitigation Plan will be completed by Fall 2014. This action will be removed in the next update.
P-2	Adopt Hazard Mitigation Plan Update.	All	High	Zebulon Board of Commissioners	Town of Zebulon	Upon approval of HMP by FEMA	The Hazard Mitigation Plan will be completed by Fall 2014. This action will be removed in the next update.
P-3	Prepare Plan maintenance report.	All	High	Zebulon Planning Department	Town of Zebulon	2015, Annually	Plan maintenance meetings have been held annually and will continue to be held going forward.
P-4	Prepare Updates of Hazard Mitigation Plan.	All	High	Zebulon Planning Department	Town of Zebulon	As needed	Multi-jurisdictional plan update occurring currently. This action will be removed in the next update.
P-5	Revise Hazard Mitigation Plan.	All	High	Zebulon Advisory Committee	Town of Zebulon	Every 5 years	Multi-jurisdictional plan update occurring currently. This action will be removed in the next update.
P-6	Keep evacuation routes open.	All	High	Zebulon Public Works, Public Safety	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
P-7	Maintain trees adjacent to power lines and critical facilities.	All	High	Zebulon Public Works, Progress Energy	Town of Zebulon, Progress Energy	Completed	Integrated into staff duties. This action will be removed in the next update.
P-8	Maintain water supply system.	All	High	Zebulon Public Works	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
P-9	Maintain sewer lift stations, including generators.	All	High	Zebulon Public Works	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
P-10	Install generators as needed at life stations.	All	High	Zebulon Public Works	Town of Zebulon	Deleted	Remove – done by City of Raleigh so this should be removed.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-11	Maintain storm drainage system.	Flooding	High	Zebulon Public Works	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
P-12	Implement disaster notification policy.	All	High	Zebulon Public Safety	Town of Zebulon	Completed	In place. This action will be removed in the next update.
P-13	Implement Community Center Use Policy.	All	High	Zebulon Parks & Recreation	Town of Zebulon	Deleted	Does not meet State and Federal qualifications
P-14	Update inclement weather policy.	All	High	All Town Departments	Town of Zebulon	Completed	Personnel Policy Update has been implemented.
P-15	Enforce subdivision standards for development in flood hazard areas.	Flood	High	Zebulon Planning & Inspections	Town of Zebulon, Wake County	2015	Development of and inclusion within UDO to take place in the future.
P-16	Further restrict development in floodplain by prohibiting development or requiring 2 feet of freeboard.	Flood	High	Zebulon Planning	Town of Zebulon	2015	Development of and inclusion within UDO to take place in the future.
P-17	Revise floodplain ordinance.	Flood	High	Zebulon Planning	Town of Zebulon	2015	Development of and inclusion within UDO to take place in the future.
P-18	Require burial of power lines for new developments.	Hurricane, Tornadoes, Winter Storms/ Freezes	Moderate	Zebulon Planning	Town of Zebulon	2015	Development of and inclusion within UDO to take place in the future.
P-19	Require new construction to comply with wind section of Building Code.	Hurricane, Tornadoes, Severe Thunderstorms	High	Zebulon Inspections	Wake County	Completed	Integrated into staff duties. This action will be removed in the next update.
P-20	Implement snow, ash, and debris removal policies.	Hurricane Tornadoes, Winter Storms/ Freezes, Wildfires	High	Zebulon Administration, Public Works	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
P-21	Prepare and implement debris removal and disposal plan.	Hurricane Tornadoes, Winter Storms/ Freezes, Wildfires	Moderate	Zebulon Administration, Public Works	Town of Zebulon	2014	Upon approval by FEMA and Board of Commissioners
P-22	Require new construction to comply with snow load requirements of Building Code.	Winter Storms/ Freezes	High	Zebulon Inspections	Wake County	Completed	Integrated into staff duties. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-23	Include flood map data on GIS system.	Flood	Moderate	Zebulon Planning	Town of Zebulon	Six Months after receipt of revised FIRM maps	These will be included in GIS systems Six Months after receipt of revised FIRM maps
P-24	Tie law enforcement to Statewide 800 megahertz system.	All	Moderate	Zebulon Public Safety	Town of Zebulon	2018	Although some work has been done to integrate this system, this is anticipated to be fully integrated by 2018
Natural Resource Protection							
NRP-1	Maintain and expand greenway system, stream buffers.	Flood	Low	Zebulon Park & Recreation	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
Public Education and Awareness							
PEA-1	Provide links to hazard notices on Town website.	All	Moderate	Zebulon Town Web Administrator	Town of Zebulon	This will occur directly prior to or during a hazard event	The town has been able to update the town website with hazard notices prior to events and will continue to do so going forward.
PEA-2	Inform public of construction requirements in hazard areas.	Flood	Moderate	Zebulon Building Inspectors	Wake County	Completed	Integrated into staff duties. This action will be removed in the next update.
PEA-3	Require disclosure of flood hazard in real estate transactions.	Flood	Moderate	Zebulon Planning Department	Town of Zebulon	2015	Development of and inclusion within UDO to take place in the future.
PEA-4	Public outreach projects.	All	Moderate	Zebulon Administration	Town of Zebulon	2018	The town will work to develop public outreach projects that help citizens become better prepared to deal with disasters.
PEA-5	Make FEMA manuals available to residents.	All	Moderate	Zebulon Planning Department	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
PEA-6	Present Plan at public meeting.	All	Moderate	Zebulon Planning	Town of Zebulon	Upon approval of HMP by FEMA	Upon approval of HMP by FEMA This action will be removed in the next update.
PEA-7	Post Plan maintenance report for public comment.	All	Moderate	Zebulon Town Manager	Town of Zebulon	Upon approval of HMP by FEMA	Upon approval of HMP by FEMA This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-8	Post copy of approval Plan in Town Hall.	All	Moderate	Zebulon Planning	Town of Zebulon	Upon approval of HMP by FEMA	Upon approval of HMP by FEMA This action will be removed in the next update.
PEA-9	Provide links to flood warnings, hurricane tracking information, tornado and severe thunderstorm warnings, winter storm warnings, wildfire warnings, and any other available hazard warning information on website.	All	Low	Zebulon Town Web Administrator	Town of Zebulon	2018	The town will work on reaching out to the public utilizing different communication channels and will review and update its outreach program
PEA-10	Make flood maps available to public.	Flood	Moderate	Zebulon Planning	Town of Zebulon	Completed	Integrated into staff duties This action will be removed in the next update.
PEA-11	Keep website updates with latest storm and emergency response information.	All	Low	Zebulon Town Web Administrator	Town of Zebulon	Completed	The town has been able to update the town website with hazard notices prior to events and will continue to do so going forward.

SECTION 10
PLAN MAINTENANCE

This section discusses how the Wake County Mitigation Strategy and Mitigation Action Plan will be implemented and how the Multi-jurisdictional Hazard Mitigation Plan will be evaluated and enhanced over time. This section also discusses how the public will continue to be involved in a sustained hazard mitigation planning process. It consists of the following three subsections:

- 10.1 Implementation and Integration
- 10.2 Monitoring, Evaluation, and Enhancement
- 10.3 Continued Public Involvement

44 CFR Requirement
44 CFR Part201.6(c)(4)(i): The plan shall include a plan maintenance process that includes a section describing the method and schedule of monitoring, evaluating and updating the mitigation plan within a five-year cycle. ***44 CFR Part 201.6(c)(4)(ii):*** The plan maintenance process shall include a process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

10.1 MONITORING AND EVALUATING THE PREVIOUS PLAN

Since the previous thirteen plans were adopted, each jurisdiction has worked to ensure that mitigation was integrated into local activities and that the mitigation plan was appropriately implemented. Each of the jurisdictions outlined a process in their previous mitigation plans for monitoring and evaluating the plan throughout the interim period between plan updates.

Each jurisdiction was ultimately successful in implementing the monitoring and evaluation processes that were outlined in previous plans as all thirteen jurisdictions held annual meetings to discuss the mitigation plan and the priorities that were outlined in it. Each jurisdiction's specific process is outlined below with an explanation of how the monitoring and evaluating process was carried out as well as any changes that were identified that would be useful to implement during the next update.

Wake County

The Wake County Hazard Mitigation Plan included an annual review process and progress report on the plan. This review process was carried out by the Environmental Services Director at the request of the County Manager every year since the previous plan was approved. During this annual review process, the Environmental Services Director solicited comments from all affected county departments via the hazard mitigation planning team. The plan was also open to comments from the general public during this timeframe.

Moreover, the Planning Board and County Board of Commissioners each received an annual report/presentation on the implementation status of the plan which included a review of mitigation actions in the plan and progress that had been made towards completing those actions.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the HMP planning team generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

Apex

The Town of Apex Hazard Mitigation Plan included an annual review process and progress report on the plan. This review process was carried out by the Planning Director at the request of the Town Manager every year since the previous plan was approved. During this annual review process, the Planning Director solicited comments from all affected town departments via the hazard mitigation planning team. The plan was also open to comments from the general public during this timeframe.

Moreover, the Planning Board and Town Council each received an annual report/presentation on the implementation status of the plan which included a review of mitigation actions in the plan and progress that had been made towards completing those actions.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the HMP planning team generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

Cary

The Town of Cary Hazard Mitigation Plan included an annual review process and progress report on the plan. This review process was carried out by the Planning Director at the request of the Town Manager every year since the previous plan was approved. During this annual review process, the Planning Director solicited comments from all affected town departments via the hazard mitigation planning team. The plan was also open to comments from the general public during this timeframe.

Moreover, the Planning Board and Town Council each received an annual report/presentation on the implementation status of the plan which included a review of mitigation actions in the plan and progress that had been made towards completing those actions.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the HMP planning team generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

Fuquay-Varina

The Town of Fuquay-Varina Hazard Mitigation Plan included an annual review process and progress report on the plan. This review process was carried out by the Town Manager or his designee every year since the previous plan was approved. During this annual review process, the Town Manager solicited comments from all affected town departments via the hazard mitigation planning team. The plan was also open to comments from the general public during this timeframe.

Moreover, the Planning Board and Board of Commissioners each received an annual report/presentation on the implementation status of the plan which included a review of mitigation actions in the plan and progress that had been made towards completing those actions.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the HMP planning team generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

Garner

The Town of Garner Hazard Mitigation Plan included an annual review process and progress report on the plan. This review process was carried out by the Town Manager or his designee every year since the previous plan was approved. During this annual review process, the Town Manager solicited comments from all affected town departments via the hazard mitigation planning team. The plan was also open to comments from the general public during this timeframe.

Moreover, the Planning Board and Town Council each received an annual report/presentation on the implementation status of the plan which included a review of mitigation actions in the plan and progress that had been made towards completing those actions.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the HMP planning team generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

Holly Springs

The Town of Holly Springs Hazard Mitigation Plan included an annual review process and progress report on the plan. This review process was carried out by the Director of Engineering at the request of the Town Manager every year since the previous plan was approved. During this annual review process, the Director of Engineering solicited comments from all affected town departments via the hazard mitigation planning team. The plan was also open to comments from the general public during this timeframe.

Moreover, the Planning Board and Town Council each received an annual report/presentation on the implementation status of the plan which included a review of mitigation actions in the plan and progress that had been made towards completing those actions.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the HMP planning team generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

Knightdale

The Town of Knightdale Hazard Mitigation Plan included an annual review process and progress report on the plan. This review process was carried out by the Planning Director every year since the previous plan was approved and was submitted to the town manager as well as posted on the town's website. During this annual review process, the Planning Director solicited comments from all affected town departments via the hazard mitigation planning team. The plan was also open to comments from the general public during this timeframe.

Moreover, the review process involved review of the plan by the mitigation planning advisory committee which evaluated the plan and other relevant documents (such as Community Assistance Visit reports). The advisory committee looked in detail at each section of the plan, including the vulnerability assessment and action plan.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the HMP planning team generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

Morrisville

The Town of Morrisville Hazard Mitigation Plan included an annual review process and progress report on the plan. This review process was carried out by the Planning Director every year since the previous plan was approved. During this annual review process, the Planning Director prepared a brief report that was distributed to the head of each department, updating the department head of the status of the plan. Each department was then given 30 days to make return comments on the plan. These comments were incorporated into a report for the Town Council.

The Town Council received an annual report on the implementation status of the plan which included a review of mitigation actions in the plan and progress that had been made towards completing those actions. A copy of the plan was also available to the public during this time.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the HMP planning team generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

Raleigh

The City of Raleigh Hazard Mitigation Plan included an annual review process and progress report on the plan. This review process was carried out by the Emergency Management Director at the request of the City Manager every year since the previous plan was approved. During this annual review process, the Emergency Management Director solicited comments from all affected city departments via the hazard mitigation planning team. The plan was also open to comments from the general public during this timeframe.

Moreover, the Planning Commission and City Council each received an annual report/presentation on the implementation status of the plan which included a review of mitigation actions in the plan and progress that had been made towards completing those actions.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the HMP planning team generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

Rolesville

The Town of Rolesville Hazard Mitigation Plan included an annual review process and progress report on the plan. This review process was carried out by the Planning Director at the request of the Town Manager every year since the previous plan was approved. During this annual review process, the Planning Director solicited comments from all affected town departments via the hazard mitigation planning team. The plan was also open to comments from the general public during this timeframe.

Moreover, the Planning Board and Board of Commissioners each received an annual report/presentation on the implementation status of the plan which included a review of mitigation actions in the plan and progress that had been made towards completing those actions.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the HMP planning team generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

Wake Forest

The Town of Wake Forest Hazard Mitigation Plan included a two year review process and progress report on the plan. This review process was carried out by the Planning Director at the request of the Town Manager every year since the previous plan was approved. During this annual review process, the Planning Director solicited comments from all affected town departments via the hazard mitigation planning team.

Planning team members were encouraged to make comments regarding the plan and to provide updates to the content of the plan at the committee meetings. In addition, coordination with other town plans was evaluated and the plans were integrated as much as possible.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the HMP planning team generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

Wendell

The Town of Wendell Hazard Mitigation Plan included an annual review process and progress report on the plan. This review process was carried out by the Planning Director/Town Manager every year since the previous plan was approved. During this annual review process, the Planning Director evaluated the vulnerability assessment and the Town Manager prepared a report summarizing the progress that had been made on the plan.

The Town Board of Commissioners received this report on the implementation status of the plan which included a review of mitigation actions in the plan and progress that had been made towards completing those actions. A copy of the plan was also available to the public during this time.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the HMP planning team generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

Zebulon

The Town of Zebulon Hazard Mitigation Plan included an annual review process and progress report on the plan. This review process was carried out by the Planning Director at the request of the Town Manager every year since the previous plan was approved. During this annual review process, the Planning Director solicited comments from all affected town departments via the hazard mitigation planning team. The plan was also open to comments from the general public during this timeframe.

Moreover, the Planning Board and Town Council each received an annual report/presentation on the implementation status of the plan which included a review of mitigation actions in the plan and progress that had been made towards completing those actions.

Although there were some minor revisions made to the plan during interim update period, there were few major revisions identified during these annual reviews and the HMP planning team generally agreed that the plan was on course and that the monitoring and evaluating process itself was sufficient to ensure implementation of the plan.

10.2 IMPLEMENTATION AND INTEGRATION

Each agency, department, or other partner participating under the Wake County Multi-jurisdictional Hazard Mitigation Plan is responsible for implementing specific mitigation actions as prescribed in the Mitigation Action Plan. Every proposed action listed in the Mitigation Action Plan is assigned to a specific “lead” agency or department in order to assign responsibility and accountability and increase the likelihood of subsequent implementation.

In addition to the assignment of a local lead department or agency, an implementation time period or a specific implementation date has been assigned in order to assess whether actions are being implemented in a timely fashion. When applicable, potential funding sources have been identified for proposed actions listed in the Mitigation Action Plan.

The participating jurisdictions will integrate this Hazard Mitigation Plan into relevant city and county government decision-making processes or mechanisms, where feasible. This includes integrating the requirements of the Hazard Mitigation Plan into other local planning documents, processes, or mechanisms, such as comprehensive or capital improvement plans, when appropriate. The members of the Wake County Hazard Mitigation Work Groups and Coordinating Committee will remain charged with ensuring that the goals and mitigation actions of new and updated local planning documents for their agencies or departments are consistent, or do not conflict with, the goals and actions of the Hazard Mitigation Plan, and will not contribute to increased hazard vulnerability in Wake County.

Since the previous thirteen plans were adopted, each jurisdiction has worked to integrate the hazard mitigation plan into other planning mechanisms where applicable/feasible. Examples of how this integration has occurred have been documented in the Implementation Status discussion provided for each of the mitigation actions found in Section 9. Specific examples of how integration has occurred include:

- Integrating the mitigation plan into reviews and updates of floodplain management ordinances;
- Integrating the mitigation plan into reviews and updates of emergency operations plans;

- Integrating the mitigation plan into review and updates of building codes; and
- Integrating the mitigation plan into the capital improvements plan through identification of mitigation actions that require local funding

Opportunities to further integrate the requirements of this Plan into other local planning mechanisms shall continue to be identified through future meetings of the Work Groups and Coordinating Committee and the annual review process described herein. Although it is recognized that there are many possible benefits to integrating components of this Plan into other local planning mechanisms, the development and maintenance of this stand-alone Multi-jurisdictional Hazard Mitigation Plan is deemed by the Work Groups and Coordinating Committee to be the most effective and appropriate method to implement local hazard mitigation actions at this time.

10.3 MONITORING, EVALUATION, AND ENHANCEMENT

Periodic revisions and updates of the Hazard Mitigation Plan are required to ensure that the goals of the Plan are kept current, taking into account potential changes in hazard vulnerability and mitigation priorities. In addition, revisions may be necessary to ensure that the Plan is in full compliance with applicable federal and state regulations. Periodic evaluation of the Plan will also ensure that specific mitigation actions are being reviewed and carried out according to the Mitigation Action Plan.

When determined necessary, the Regional Work Groups shall meet in March of every year to evaluate the progress attained and to revise, where needed, the activities set forth in the Plan. The findings and recommendations of the regional Work Groups be documented in the form of a report that can be shared with interested City, County, and the Coordinating Committee members. The Regional Work Groups will also meet following any disaster events warranting a reexamination of the mitigation actions being implemented or proposed for future implementation. This will ensure that the Plan is continuously updated to reflect changing conditions and needs within Wake County. The Wake County Emergency Management Coordinator will be responsible for reconvening the Regional Work Groups and the Coordinating Committee for these reviews.

<u>Five Year Plan Review</u>

The Plan will be thoroughly reviewed by the Regional Work Groups and Coordinating Committee every five years to determine whether there have been any significant changes in Wake County that may, in turn, necessitate changes in the types of mitigation actions proposed. New development in identified hazard areas, an increased exposure to hazards, an increase or decrease in capability to address hazards, and changes to federal or state legislation are examples of factors that may affect the necessary content of the Plan.

The plan review provides Wake County/municipal officials with an opportunity to evaluate those actions that have been successful and to explore the possibility of documenting potential losses avoided due to the implementation of specific mitigation measures. The plan review also provides the opportunity to address mitigation actions that may not have been successfully implemented as assigned. The Wake County Emergency Management Coordinator will be responsible for reconvening the Regional Work Groups and Coordinating Committee and conducting the five-year review.

During the five-year plan review process, the following questions will be considered as criteria for assessing the effectiveness and appropriateness of the Plan:

- Do the goals address current and expected conditions?
- Has the nature or magnitude of risks changed?
- Are the current resources appropriate for implementing the Plan?
- Are there implementation problems, such as technical, political, legal or coordination issues with other agencies?
- Have the outcomes occurred as expected?
- Did County departments participate in the plan implementation process as assigned?

Following the five-year review, any revisions deemed necessary will be summarized and implemented according to the reporting procedures and plan amendment process outlined herein. Upon completion of the review and update/amendment process, the Wake County Multi-jurisdictional Hazard Mitigation Plan will be submitted to the State Hazard Mitigation Officer at the North Carolina Division of Emergency Management (NCDEM) for final review and approval in coordination with the Federal Emergency Management Agency (FEMA).

Because the plan update process can take several months to complete, and because Federal funding may be needed to update the plan, it is recommended that the five-year review process begin at the beginning of the third year after the plan was last approved. This will allow the participants in the Wake County Multi-jurisdictional Hazard Mitigation Plan to organize in order to seek Federal funding if necessary and complete required plan update documentation before the plan expires at the end of the fifth year.

Disaster Declaration

Following a disaster declaration, the Wake County Multi-jurisdictional Hazard Mitigation Plan will be revised as necessary to reflect lessons learned, or to address specific issues and circumstances arising from the event. It will be the responsibility of the Wake County Emergency Management Coordinator to reconvene the Regional Work Groups and Coordinating Committee and ensure the appropriate stakeholders are invited to participate in the plan revision and update process following declared disaster events.

Reporting Procedures

The results of the five-year review will be summarized by the Regional Work Groups in a report that will include an evaluation of the effectiveness of the Plan and any required or recommended changes or amendments. The report will also include an evaluation of implementation progress for each of the proposed mitigation actions, identifying reasons for delays or obstacles to their completion along with recommended strategies to overcome them.

Plan Amendment Process

Upon the initiation of the amendment process, representatives from Wake County and the participating municipalities will forward information on the proposed change(s) to all interested parties including, but not limited to, all directly affected County/municipal departments, residents, and businesses. Information will also be forwarded to the North Carolina Division of Emergency Management. This information will be disseminated in order to seek input on the proposed amendment(s) for no less than a 45-day review and comment period.

At the end of the 45-day review and comment period, the proposed amendment(s) and all comments will be forwarded to the Regional Work Groups and the Coordinating Committee for final consideration. The Regional Work Groups and the Coordinating Committee will review the proposed amendment along with the comments received from other parties, and if acceptable, the committee will submit a recommendation for the approval and adoption of changes to the Plan.

In determining whether to recommend approval or denial of a Plan amendment request, the following factors will be considered by the Regional Work Groups and the Coordinating Committee:

- There are errors, inaccuracies, or omissions made in the identification of issues or needs in the Plan.
- New issues or needs have been identified which are not adequately addressed in the Plan.
- There has been a change in information, data, or assumptions from those on which the Plan is based.

Upon receiving the recommendation from the Regional Work Groups and the Coordinating Committee, and prior to adoption of the Plan, the participating jurisdictions will hold a public hearing, if deemed necessary. The governing bodies of each participating jurisdiction will review the recommendation from the Regional Work Groups and the Coordinating Committee (including the factors listed above) and any oral or written comments received at the public hearing. Following that review, the governing bodies will take one of the following actions:

- Adopt the proposed amendments as presented;
- Adopt the proposed amendments with modifications;
- Refer the amendments request back to the Regional Work Groups and the Coordinating Committee for further revision; or
- Defer the amendment request back to the Regional Work Groups and the Coordinating Committee for further consideration and/or additional hearings.

10.4 CONTINUED PUBLIC INVOLVEMENT

44 CFR Requirement
44 CFR Part 201.6(c)(4)(iii): The plan maintenance process shall include a discussion on how the community will continue public participation in the plan maintenance process.

Public participation is an integral component to the mitigation planning process and will continue to be essential as this Plan evolves over time. As described above, significant changes or amendments to the Plan shall require a public hearing prior to any adoption procedures.

Other efforts to involve the public in the maintenance, evaluation, and revision process will be made as necessary. These efforts may include:

- Advertising meetings of the Regional Work Groups and the Coordinating Committee in local newspapers, public bulletin boards and/or County and municipal office buildings;

- Designating willing and voluntary citizens and private sector representatives as official members of the Regional Work Groups and the Coordinating Committee;
- Utilizing local media to update the public on any maintenance and/or periodic review activities taking place;
- Utilizing the websites of participating jurisdictions to advertise any maintenance and/or periodic review activities taking place; and
- Keeping copies of the Plan in public libraries.

Annex A
Town of Apex

This annex includes jurisdiction-specific information for the Town of Apex. It consists of the following five subsections:

- A.1 Town of Apex Community Profile
- A.2 Town of Apex Risk Assessment
- A.3 Town of Apex Vulnerability Assessment
- A.4 Town of Apex Capability Assessment
- A.5 Town of Apex Mitigation Strategy

A.1 TOWN OF APEX COMMUNITY PROFILE

A.1.1 Geography and the Environment

Apex is town located in Wake County in the state of North Carolina. It was incorporated in 1873 and named due to its location at the highest point of the Chatham Railroad between Richmond, Virginia and Jacksonville, Florida.

Overall, Wake County is known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Summer temperatures generally venture into the 90s for highs and cool off to the 70s at night. Winter temperatures in can drop to below freezing but generally highs are in the 50s. Rainfall is most common in the summer months but occurs consistently throughout the year.

A.1.2 Population and Demographics

According to the 2010 Census, Apex has a population of 37,476 people. The jurisdiction has seen exceptional growth between 2000 and 2010, and the population density is almost 2,500 people per square mile. Population counts from the US Census Bureau for 1990, 2000, and 2010 are presented in **Table A.1**.

TABLE A.1: POPULATION COUNTS FOR APEX

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
APEX	4,968	20,212	37,476	85.41%

Source: US Census Bureau

The racial characteristics of the jurisdiction are presented in **Table A.2**. Whites make up the majority of the population in the jurisdiction, accounting for nearly 80 percent of the population.

TABLE A.2: DEMOGRAPHICS OF APEX

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
APEX	79.5%	7.6%	0.3%	12.6%	7.1%

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

A.1.3 Housing

According to the 2010 US Census, there are 13,922 housing units in Apex, the majority of which are single family homes or mobile homes. Housing information for the jurisdiction is presented in **Table A.3**.

TABLE A.3: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Seasonal Units, Percent (2010)	Median Home Value (2007-2011)
APEX	8,028	13,922	5.0%	$258,500

Source: US Census Bureau

A.1.4 Infrastructure

Transportation

There are several major roadways that residents of Apex utilize. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs, one of which is I-540/NC-540 which is a partly completed loop that connects the jurisdiction to many of the other municipalities. In addition to the Interstate, there are many major highways that residents of the municipality utilize. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways in the include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities

Electrical power is provided by the Town of Apex that is part of the Electricities of North Carolina and Duke Energy. Water and sewer service is provided by two main entities as well: The Town of Apex Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

Community Facilities
There are a number of buildings and community facilities located throughout Apex. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 4 fire stations, 1 police station, and 10 public schools located within the jurisdiction. There is one medical care facility located in the municipality

Citizens also have access to several parks, including three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the county, including the American Tobacco Trail which is a rails to trails project that is open to a wide variety of non-motorized uses.

A.1.5 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land as parks. There are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the jurisdiction consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

A.1.6 Employment and Industry

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

A.2 TOWN OF APEX RISK ASSESSMENT

This subsection includes hazard profiles for each of the significant hazards identified in Section 4: *Hazard Identification* as they pertain to Apex. Each hazard profile includes a description of the hazard's location and extent, notable historical occurrences, and the probability of future occurrences. Additional information can be found in Section 5: *Hazard Profiles*.

A.2.1 Drought

Location and Spatial Extent
Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, Apex has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that the county would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Historical Occurrences

According to the North Carolina Drought Monitor, Apex has had drought occurrences all of the last fourteen years (2000-2013). **Table A.4** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE A.4: HISTORICAL DROUGHT OCCURRENCES IN APEX

Abnormally Dry | Moderate Drought | Severe Drought | Extreme Drought | Exceptional Drought

	Apex
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that Apex has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

A.2.2 Extreme Heat

Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to any geographic or political boundaries. All of Apex is susceptible to extreme heat conditions.

Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Apex. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the region. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the county. The most centralized location is in Raleigh at North Carolina State University. **Table A.5** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table A.5: Average Maximum Temperature in Raleigh, Wake County

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

A.2.3 Hailstorm

Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Apex is uniformly exposed to severe thunderstorms; therefore, all areas are equally exposed to hail which may be produced by such storms.

Historical Occurrences

According to the National Climatic Data Center, 12 recorded hailstorm events have affected Apex since 1993.[1] **Table A.6** is a summary of the hail events in Apex. **Table A.7** provides detailed information about each event that occurred. In all, hail occurrences resulted in over $0 (2013 dollars) in property damages. Hail ranged in diameter from 0.75 inches to 1.75 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value.

Table A.6: Summary of Hail Occurrences in Apex

Location	Number of Occurrences	Property Damage (2013)
Apex	12	$0

Source: National Climatic Data Center

[1] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Apex. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

TABLE A.7: HISTORICAL HAIL OCCURRENCES IN APEX

	Date	Magnitude	Deaths/Injuries	Property Damage*
Apex				
Apex	5/19/1993	1.75 in.	0/0	$0
Apex	5/19/1993	1 in.	0/0	$0
Apex	5/19/1993	1.75 in.	0/0	$0
Apex	3/23/1995	1.75 in.	0/0	$0
APEX	3/21/1999	0.75 in.	0/0	$0
APEX	4/22/2006	1 in.	0/0	$0
APEX	5/14/2006	1.75 in.	0/0	$0
APEX	6/13/2007	0.75 in.	0/0	$0
APEX	6/1/2008	0.75 in.	0/0	$0
APEX	6/21/2008	0.88 in.	0/0	$0
APEX	3/23/2011	0.75 in.	0/0	$0
APEX	6/21/2011	1 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that Apex has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the county.

A.2.4 Hurricane and Tropical Storm

Location and Spatial Extent

Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Apex. The entire jurisdiction is equally susceptible to hurricane and tropical storms.

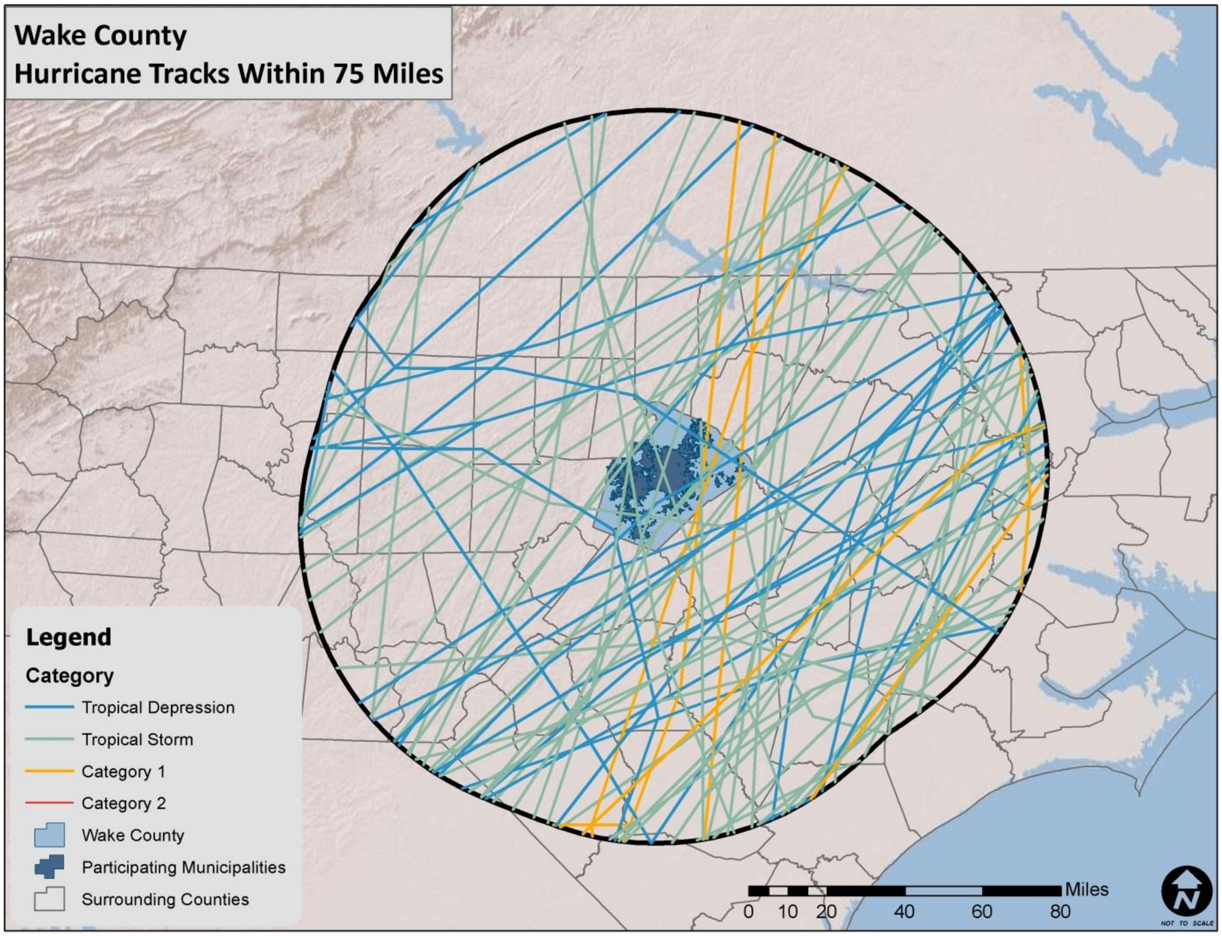
Historical Occurrences

According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[2] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms have traversed directly through Wake County as shown in **Figure A.1**. **Table A.8** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

[2] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

FIGURE A.1: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE A.8: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1
1882	NOT NAMED	53	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm
1959	CINDY	26	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression
2008	HANNA	40	Tropical Storm

Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Apex between 1950 and 2013. These storms are listed in **Table A.9** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE A.9: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made in 1996 (Hurricane Fran), 1999 (Hurricane Floyd), and 2003 (Hurricane Isabel) for the county.[3]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Tropical Storm Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

Probability of Future Occurrences
Given the inland location of the jurisdiction, it is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Apex. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the jurisdiction is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

[3] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

A.2.5 Lightning

Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Apex is uniformly exposed to lightning.

Historical Occurrences

According to the National Climatic Data Center, there have been two recorded lightning events in Apex since 1950, as listed in summary **Table A.10** and detailed in **Table A.11**.[4] However, it is certain that more lightning events have in fact impacted the jurisdiction. Many of the reported events are those that caused damage, and it should be expected that damages are likely much higher for this hazard than what is reported.

TABLE A.10: SUMMARY OF LIGHTNING OCCURRENCES IN APEX

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Apex	2	0/0	$95,703

Source: National Climatic Data Center

TABLE A.11: HISTORICAL LIGHTNING OCCURRENCES IN APEX

	Date	Deaths/Injuries	Property Damage*	Details
Apex				
Apex	5/19/1993	0/0	$90,075	Lightning caused $5,000 of structural damage to a house.
APEX	7/27/2010	0/0	$5,628	A very moist and moderately unstable air mass combined with a weak upper level disturbance to cause minor flash flooding and an isolated severe storm..

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Although there were not a high number of historical lightning events reported in Apex via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S. National Lightning Detection Network (NLDN®), Apex is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the jurisdiction.

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Apex. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

A.2.6 Severe Thunderstorm/High Wind

Location and Spatial Extent

A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Also, Apex typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Apex has uniform exposure to an event and the spatial extent of an impact could be large.

Historical Occurrences

Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011.[5] According to NCDC, there have been 9 reported thunderstorm/high wind events since 1994 for high wind and since 1950 for thunderstorms.[6] These events caused over $50,000 (2013 dollars) in damages. **Table A.12** summarizes this information. **Table A.13** presents detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event.[7]

TABLE A. 12: SUMMARY OF THUNDERSTORM/HIGH WIND OCCURRENCES IN APEX

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Apex	9	0/0	$51,338

Source: National Climatic Data Center

TABLE A.13: HISTORICAL THUNDERSTORM/HIGH WIND OCCURRENCES IN APEX

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Apex					
Apex	8/3/1993	THUNDERSTORM WINDS	0 kts.	0/0	$9,008
APEX	7/14/2004	TSTM WIND	50 kts.	0/0	$0
APEX	7/19/2006	TSTM WIND	50 kts.	0/0	$0
APEX	4/5/2011	THUNDERSTORM WIND	50 kts.	0/0	$32,782
APEX	8/14/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
APEX	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
APEX	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$2,122
APEX	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$0

[5] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.

[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional thunderstorm events have occurred in Apex. As additional local data becomes available, this hazard profile will be amended.

[7] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
APEX	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$7,426

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire jurisdiction.

A.2.7 Tornado

Location and Spatial Extent

Tornadoes occur throughout the state of North Carolina, and thus in Apex. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Apex is uniformly exposed to this hazard.

Historical Occurrences

Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there has been one recorded tornado events in Apex since 1956 (**Table A.14**), resulting in nearly $0 (2013 dollars) in property damages.[8] Detailed information on this event can be found in **Table A.15**. The magnitude of this tornado was a F0 in intensity, although an F5 event is possible. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is likely that a high number of occurrences have gone unreported over the past 50 years.

TABLE A.14: SUMMARY OF TORNADO OCCURRENCES IN APEX

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Apex	1	0/0	$0

Source: National Climatic Data Center

TABLE A.15: HISTORICAL TORNADO IMPACTS IN APEX

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Apex					
Apex	9/27/2004	F0	0/0	$0	A tornado touched down near the intersection of Holly Springs Road and Kildaire Farm Road. Minor property damage occurred to a few mobile homes, and a few trees and power lines were blown down. The

[8] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Apex. As additional local data becomes available, this hazard profile will be amended.

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
					tornado lifted briefly, and then touched down again on the north side of Apex were several large trees were blown down, especially near the intersection of Schiefflin Road and James road, and along Culvert Street.

*Property Damage is reported in 2013 dollars.
Source: NCDC

2011 Tornadoes- April 16, 2011
In 2011, the county and all of its jurisdictions were impacted by one of the worst tornado-related events in the county's recorded history. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries.

Probability of Future Occurrences
According to historical information, tornado events are not an annual occurrence for the jurisdiction. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Apex experience a direct tornado strike. The probability of future tornado occurrences affecting Apex is likely (10-100 percent annual probability).

A.2.8 Winter Storm and Freeze

Location and Spatial Extent
Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Apex is accustomed to smaller scale severe winter weather conditions and often receives severe winter weather during the winter months. Given the atmospheric nature of the hazard, the entire jurisdiction has uniform exposure to a winter storm.

Historical Occurrences
Severe winter weather has resulted in six disaster declarations in Apex. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. [9] According to the National Climatic Data Center, there have been no recorded winter storm events in Apex since 1993 (**Table A.16**).[10] These events resulted in $0 (2013 dollars) in damages. However, there have been 28 recorded countywide events and most severe winter weather events are only recorded at the county level.

[9] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[10] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional winter storm conditions have affected Apex.

TABLE A.16: SUMMARY OF WINTER STORM EVENTS IN APEX

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Apex	0	0/0	$0

Source: National Climatic Data Center

There have been several severe winter weather events to impact Apex. The text below describes one of the major events and associated impacts on the county. Similar impacted can be expected with severe winter weather.

1996 Winter Storm
This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

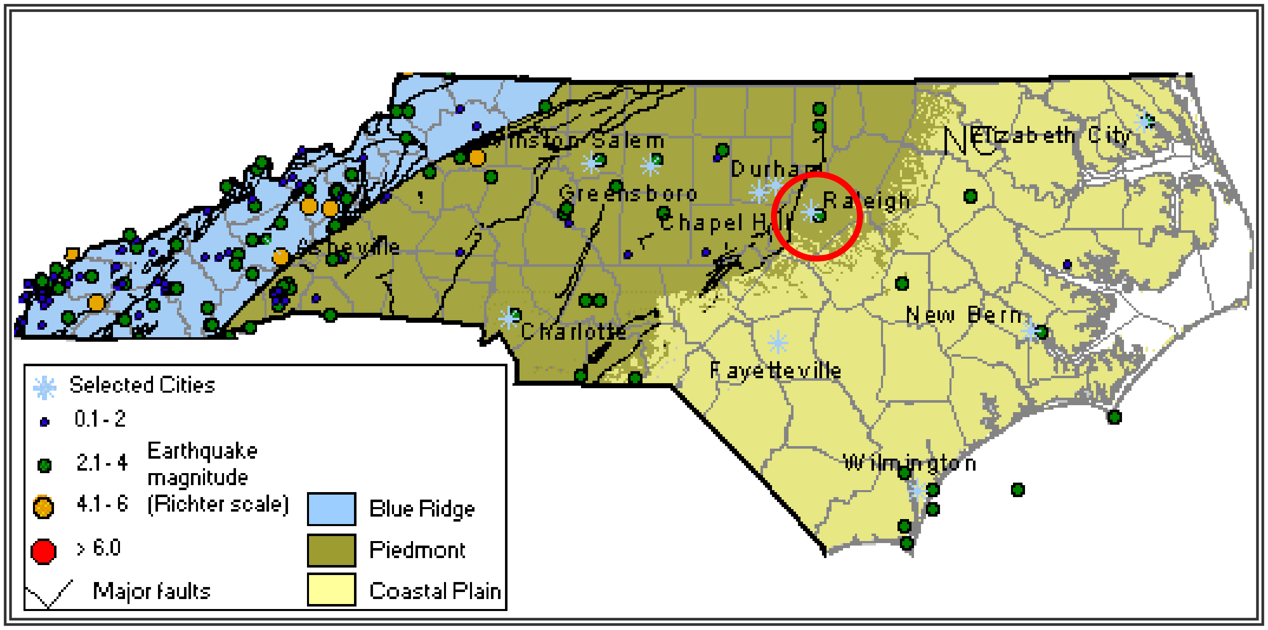
Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and power outages. Furthermore, citizens may resort to using inappropriate heating devices that could to fire or an accumulation of toxic fumes.

Probability of Future Occurrences
Winter storm events will remain a somewhat regular occurrence in Apex due to location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

A.2.9 Earthquake

Location and Spatial Extent
Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina. **Figure A.2** is a map showing geological and seismic information for North Carolina.

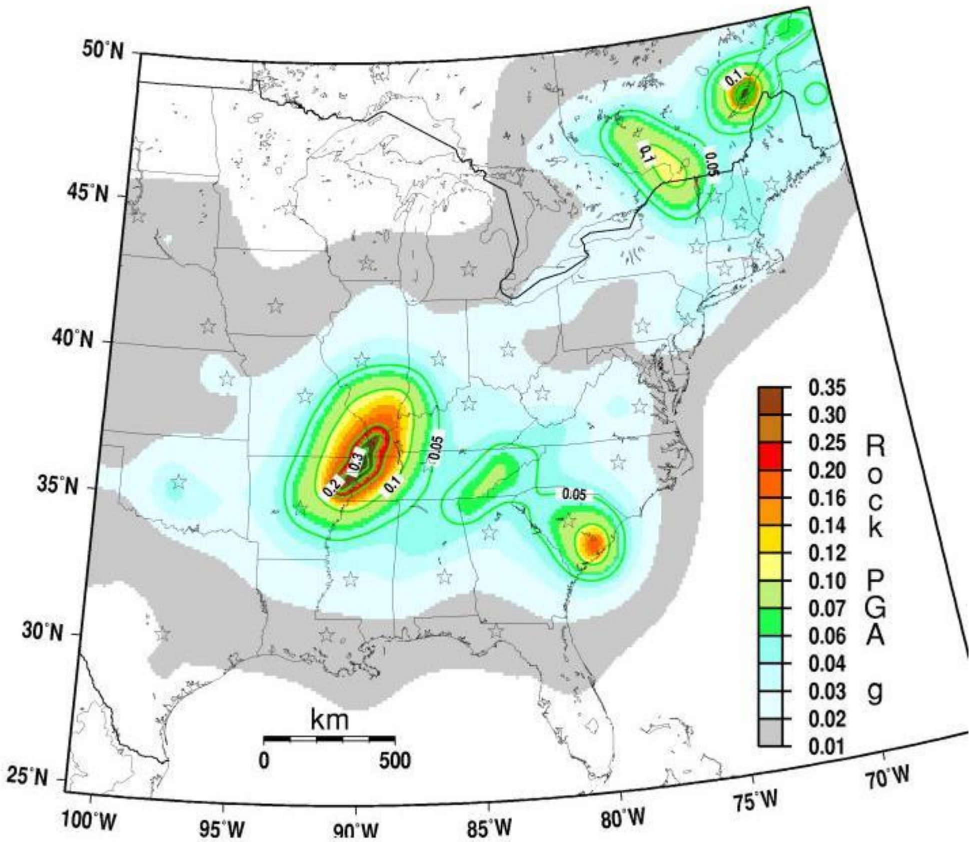
FIGURE A.2: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure A.3 shows the intensity level associated with Apex, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Apex lies within an approximate zone of level “2” to “3” ground acceleration. This indicates that the county exists within an area of moderate seismic risk.

FIGURE A.3: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

Historical Occurrences

Although no earthquakes are known to have occurred directly in Apex since 1874, several have occurred in the county or within the region and affected the municipality. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table A.17** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table A.18** presents a detailed occurrence of each event including the date, distance for the epicenter, and Modified Mercalli Intensity (if known). [11]

TABLE A.17: SUMMARY OF SEISMIC ACTIVITY IN APEX

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Apex	--	--	--

Source: National Geophysical Data Center

[11] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

TABLE A.18: SIGNIFICANT SEISMIC EVENTS IN APEX (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI (magnitude)
Apex				
None reported				

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Apex, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table A.19.**

TABLE A.19: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 - 1	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928*	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957*	Buncombe County, NC	3.7	VI	VI
11/24/1957*	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973*	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Apex occurrences.
** Conflicting reports on this event, intensity in North Carolina could have been either V or VI
Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Apex is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. The annual probability level for the county is estimated between 1 and 10 percent (possible).

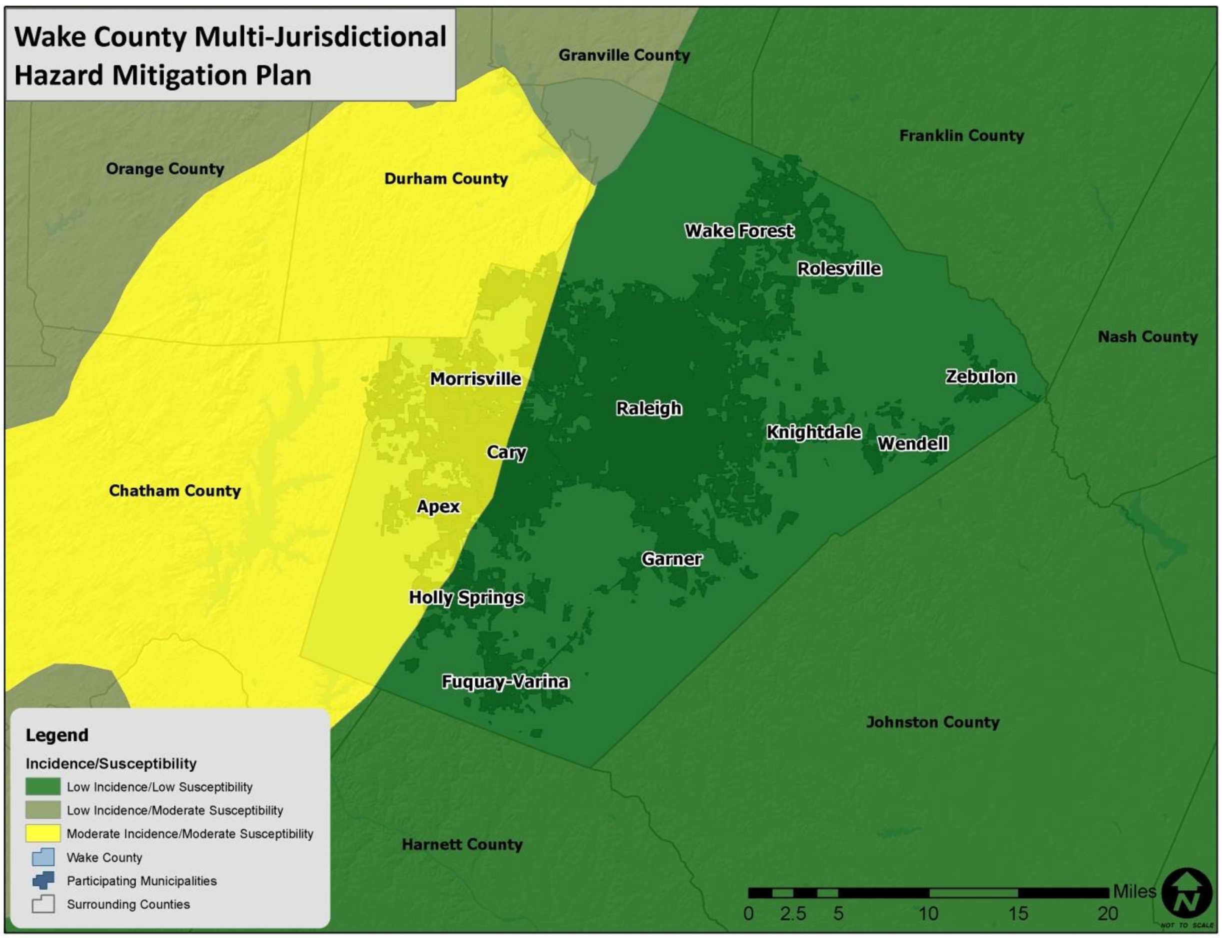
A.2.10 Landslide

Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Apex, although the overall risk is relatively low.

According to **Figure A.4** below, the majority of the county has low landslide activity. However there is a small area along the western border of the county (which includes parts of Apex) that has a moderate incidence and moderate susceptibility. In all other areas, there is low susceptibility.

FIGURE A.4: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

Historical Occurrences

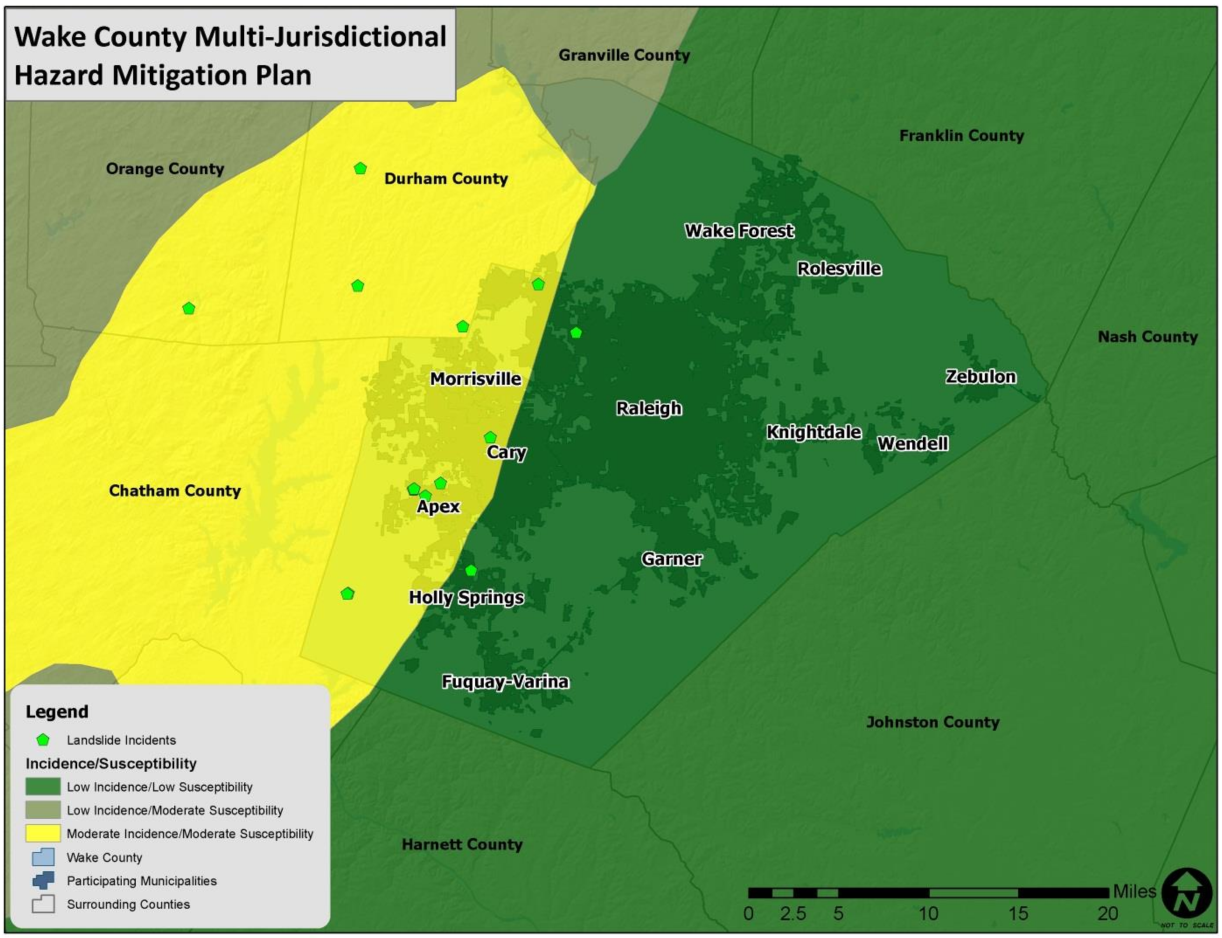
Steeper topography in some areas of Apex make the planning area susceptible to landslides. Most landslides are caused by heavy rainfall in the area. Building on steep slopes that was not previously possible also contributes to risk. **Table A.20** presents a summary of the landslide occurrence events as provided by the North Carolina Geological Survey[12]. The georeferenced locations of the landslide events presented in the aforementioned tables are presented in **Figure A.5**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred in Apex.

TABLE A.20: SUMMARY OF LANDSLIDE ACTIVITY IN APEX

Location	Number of Occurrences
Apex	3

Source: North Carolina Geological Survey

FIGURE A.5: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for

[12] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Apex have greater risk than others given factors such as steepness on slope and modification of slopes.

A.2.11 Dam and Levee Failure

Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table A.21** explains these classifications.

TABLE A. 21: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

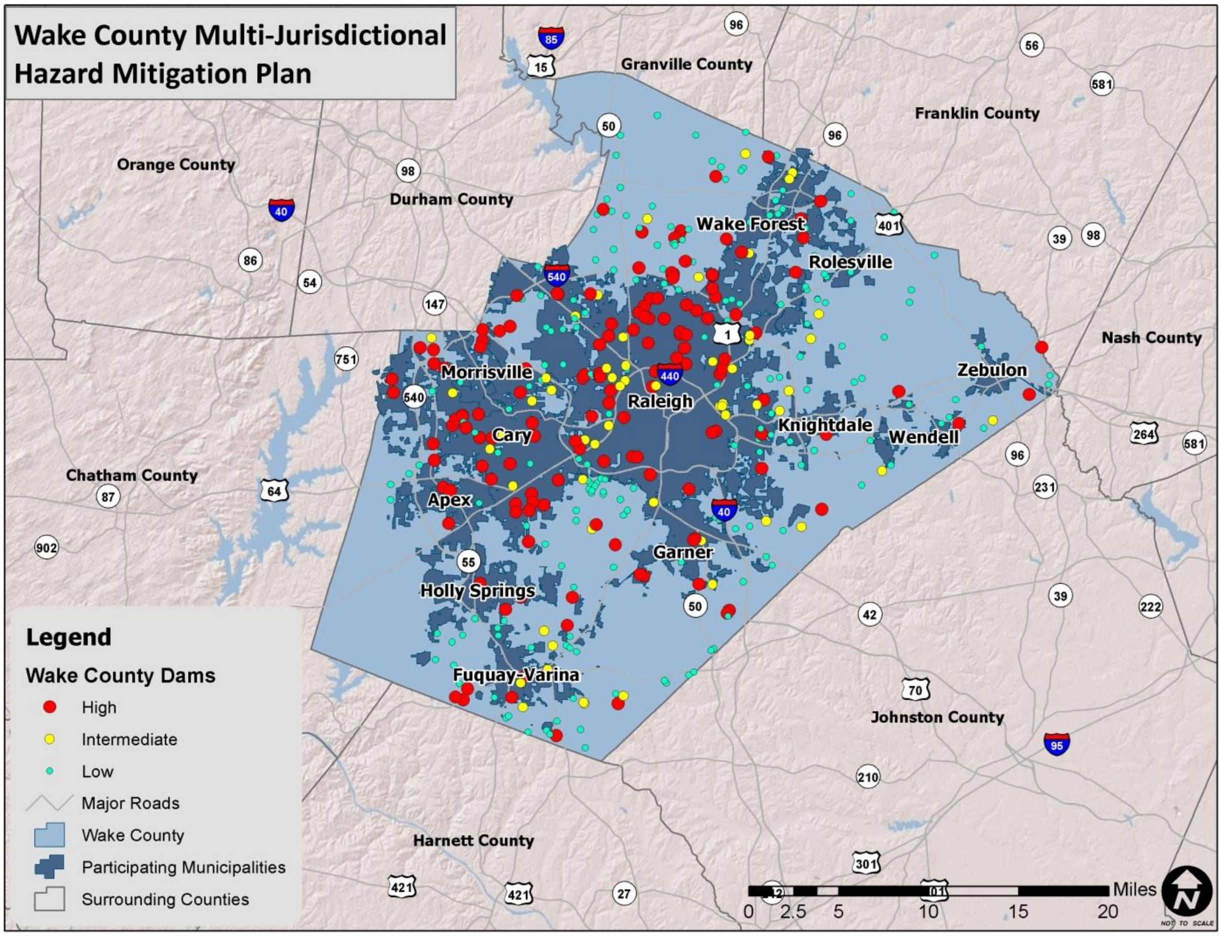
Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

According to the North Carolina Division of Land Management there are 5 dams in Apex.[13] **Figure A.6** shows the dam location and the corresponding hazard ranking for each. Of these dams, three are classified as high hazard potential. These high hazard dams are listed in **Table A.22**.

[13] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE A.6: WAKE COUNTY DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE A.22: APEX HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Apex				
Lake Pine Dam	High	0	163	Local Gov
Haddon Hall Dam	High	5	42	Private
Haddon Hall Upper Dam	High	1.1	0	Private

Source: North Carolina Division of Land Resources, 2012

It should also be noted that the North Carolina dam classification regulations were recently updated. As a result of the change, more dams are generally classified as high hazard.

Historical Occurrences

No dam breaches were reported in Apex. However, several breach scenarios in the jurisdiction could cause substantial damage.

Probability of Future Occurrences
Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

A.2.12 Erosion

Location and Spatial Extent
Erosion in Apex is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Apex soils have greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Apex, particularly along the banks of rivers and streams, but it is not an extreme threat. No areas of concern were reported by the planning committee.

Historical Occurrences
Several sources were vetted to identify areas of erosion in Apex. This includes searching local newspapers, interviewing local officials, and reviewing the previous hazard mitigation plan. Little information could be found and erosion was not addressed in the previous Apex hazard mitigation plan.

Probability of Future Occurrences
Erosion remains a natural, dynamic, and continuous process for Apex, and it will continue to occur. The annual probability level assigned for erosion is possible (between 1 and 10 percent annually).

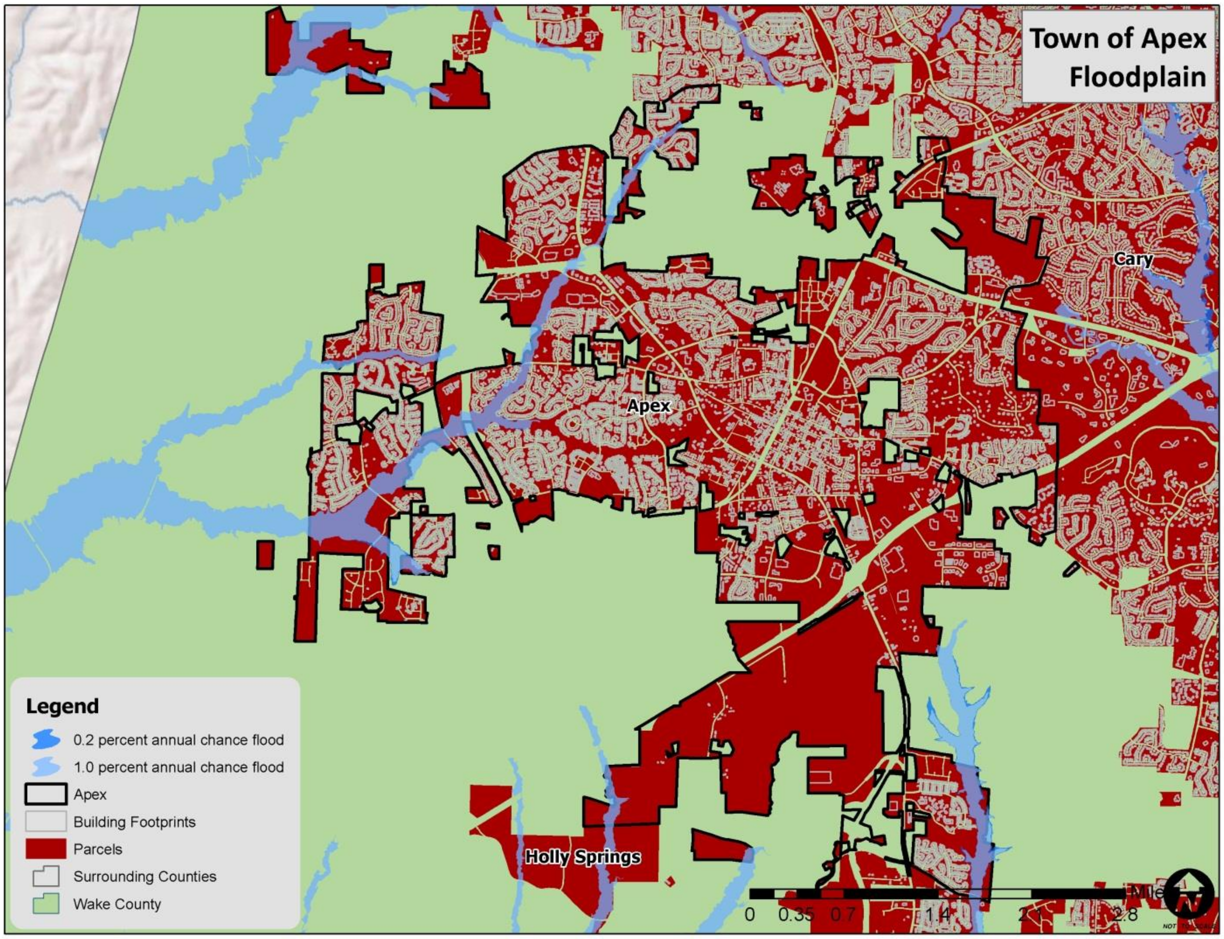
A.2.13 Flood

Location and Spatial Extent
There are areas in Apex that are susceptible to flood events. Special flood hazard areas in the jurisdiction were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[14] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 15 square miles that make up Apex, there are 0.68 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain).

These flood zone values account for 4.5 percent of the total land area in Apex. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas. **Figure A.7** illustrates the location and extent of currently mapped special flood hazard areas for Apex based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.

[14] The county-level DFIRM data used for Apex were updated in 2010.

FIGURE A.7: SPECIAL FLOOD HAZARD AREAS IN APEX



Source: Federal Emergency Management Agency

Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported a total of 2 events in Apex since 1993.[15] A summary of these events is presented in **Table A.23**. These events accounted for over $0 (2013 dollars) in property damage in the county.[16] Specific information on flood events, including date, type of flooding, and deaths and injuries, can be found in **Table A.24**.

TABLE A.23: SUMMARY OF FLOOD OCCURRENCES IN APEX

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Apex	2	0/0	$0

Source: National Climatic Data Center

[15] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.
[16] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

TABLE A.24: HISTORICAL FLOOD EVENTS IN APEX

	Date	Type	Deaths/ Injuries	Property Damage*
Apex				
APEX	7/27/2010	FLASH FLOOD	0/0	$0
APEX	7/27/2010	FLASH FLOOD	0/0	$0

Source: National Climatic Data Center

Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there have been 0 flood losses reported in Apex through the National Flood Insurance Program (NFIP) since 1978. A summary of these figures for the jurisdiction is provided in **Table A.25**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that additional instances of flood loss in Apex were either uninsured, denied claims payment, or not reported.

TABLE A.25: SUMMARY OF INSURED FLOOD LOSSES IN APEX

Location	Flood Losses	Claims Payments
Apex	0	$0

Source: FEMA, NFIP

Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

As of July 2013, there are 0 non-mitigated repetitive loss properties located in Apex, which accounted for 0 losses and $0 in claims payments under the NFIP. Without mitigation, repetitive loss properties will likely continue to experience flood losses. **Table A.26** presents detailed information on repetitive loss properties and NFIP claims and policies for Apex.

TABLE A.26: SUMMARY OF REPETITIVE LOSS PROPERTIES IN APEX

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Apex	0	-	0	$0	$0	$0	$0

Source: National Flood Insurance Program

Probability of Future Occurrences

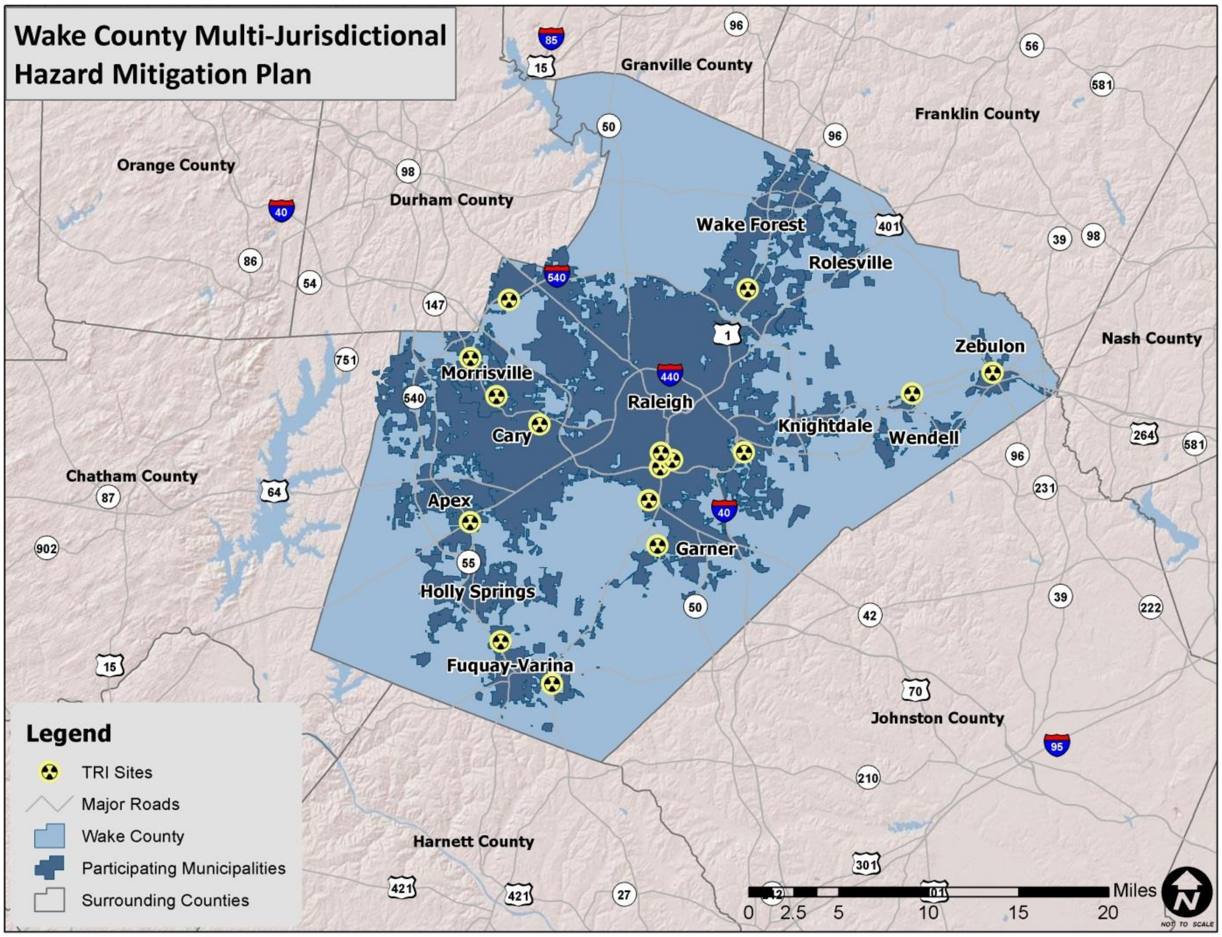
Flood events will remain a threat in areas prone to flooding in Apex, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability) The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above**,** which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

A.2.14 Hazardous Materials Incidents

Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Apex has one TRI site. This site is shown in **Figure A.8.**

FIGURE A.8: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the jurisdiction via roadways and rail. All roads that permit hazardous material transport are considered potentially at risk to an incident.

Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table A.27 presents detailed information on historic HAZMAT incidents reported in Apex.

TABLE A.27: SUMMARY OF HAZMAT INCIDENTS IN APEX

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Apex							
N/A	10/5/2006	APEX	Fixed facility	Yes	0/30	-	>50 gallons

Source: USDOT PHMSA

Probability of Future Occurrences

Given the location of one toxic release inventory site in Apex and several roadways and rails that transport hazardous materials, it is possible that a hazardous material incident may occur in the jurisdiction (between 1 percent and 10 percent annual probability). Local officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

A.2.15 Wildfire

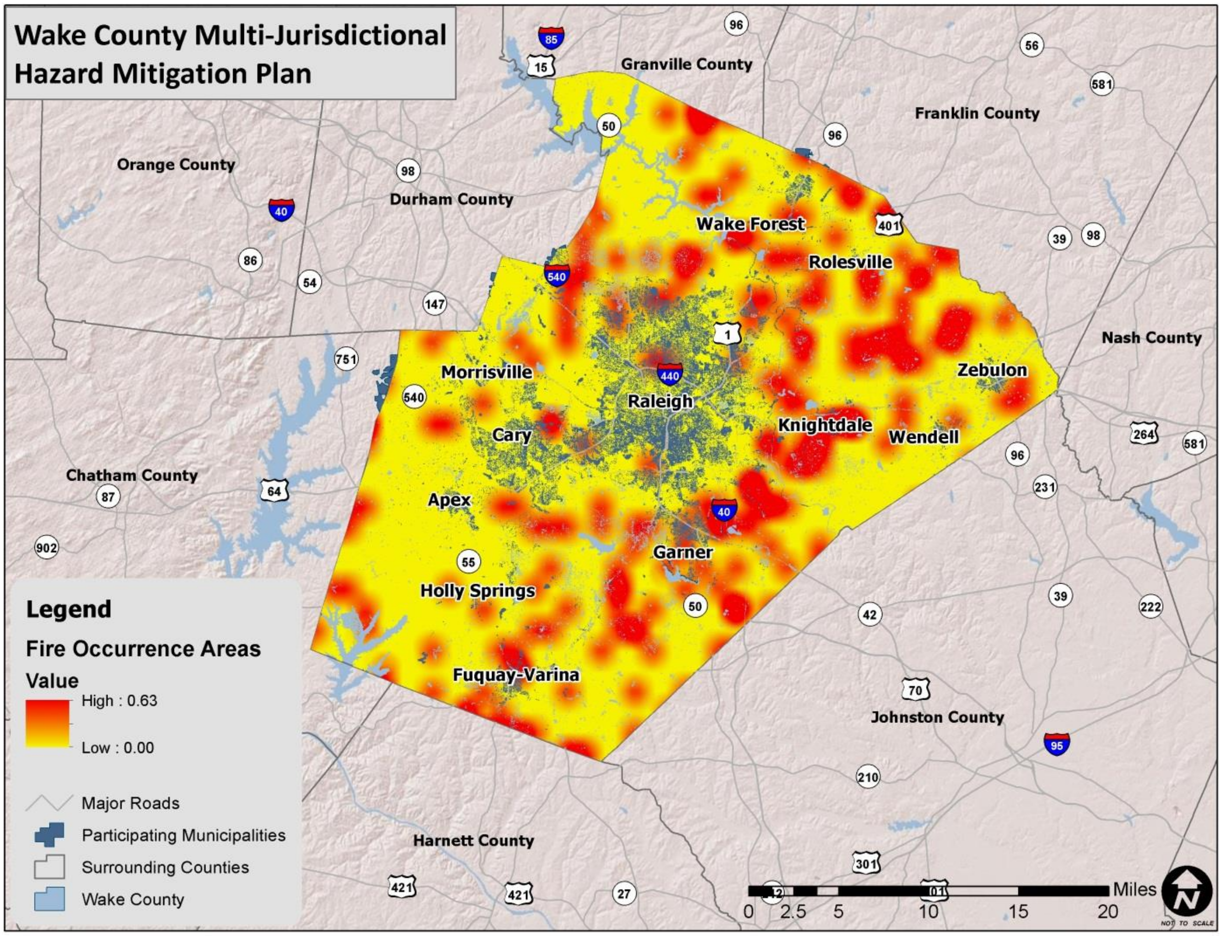
Location and Spatial Extent

The entire jurisdiction is at some risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas.

Historical Occurrences

Figure A.9 shows the Fire Occurrence Areas (FOA) in Apex based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. Therefore, even areas classified as at relatively high risk within the county are a relatively low risk compared to other areas of the state.

FIGURE A.9: HISTORIC WILDFIRE EVENTS IN APEX



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of 16 wildfires annually which burn an average of 98 acres per year. The data indicates that most of these fires are small, averaging six acres per fire. **Table A.28** lists the number of reported wildfire occurrences in the county between the years 2003 and 2012.

TABLE A.28: HISTORICAL WILDFIRE OCCURRENCES IN WAKE COUNTY

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Apex. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Apex for future wildfire events is possible (a 1 and 10 percent annual probability).

A.2.16 Nuclear Accident

Location and Spatial Extent

The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station.

Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 "Alerts" and 28 "Notice of Unusual Events" since 1986, which are shown in **Table A.29**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table A.29: Shearon Harris Emergency Declaration History

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on "B" Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).

Emergency Declaration	Date	Description
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of “A” Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - “B” diesel generator was being worked on; in accordance with test procedures, “A” diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported “Notice of Unusual Events” since 1986, which is shown in **Table A.30**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table A.30: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Probability of Future Occurrences

A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

A.2.17 Terror Threat

Location and Spatial Extent

A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table A.31** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

TABLE A.31 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food ▪ Banking and Finance ▪ Chemical ▪ Commercial Facilities ▪ Communications ▪ Critical Manufacturing ▪ Dams ▪ Defense Industrial Base ▪ Emergency Services ▪ Energy	▪ Government Facilities ▪ Healthcare and Public Health ▪ Information Technology ▪ National Monuments and Icons ▪ Nuclear Reactors, Materials, and Waste ▪ Postal and Shipping ▪ Transportation Systems ▪ Water

Historical Occurrences

Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

Probability of Future Occurrences

Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

A.2.18 Conclusions on Hazard Risk

The hazard profiles presented above were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and

experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

Hazard Extent

Table A.32 describes the extent of each natural hazard identified for Apex. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE A.32 EXTENT OF APEX HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page A:4). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Apex has received this ranking three times over the fourteen year reporting period.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Apex was 1.75 inches. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), Apex is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Thunderstorm Wind/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Apex was reported at 50 knots (approximately 58 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). The greatest magnitude reported was an F0 (reported on September 7, 2004).
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Apex. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is between low and moderate in Apex. There is also moderate susceptibility in some areas.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). Of the 5 dams in Apex, 3 are classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records located in Apex.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 4.5 percent of the total land area in Apex. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second.
Other Hazards	
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incident reported in the region is 75 LGA released on the highway in Raleigh. It should be noted that larger events are possible.
Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).

Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

Priority Risk Index Results

In order to draw some meaningful planning conclusions on hazard risk for Apex, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). More information on the PRI and how it was calculated can be found in Section 5.20.2.

Table A.33 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups and Coordinating Committee. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE A.33: SUMMARY OF PRI RESULTS FOR APEX

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	**2.5**
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	**2.4**
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	**2.5**
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	**2.1**
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	**3.1**
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.7**
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	**2.5**
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2**
Landslide	Possible	Minor	Small	Less than 6 hours	Less than 6 hours	**1.8**
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	**1.8**
Flood	Likely	Critical	Small	6 to 12 hours	Less than 1 week	**2.8**
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	**2**
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	**2.6**
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	**2.4**

A.2.16 Final Determinations on Hazard Risk

The conclusions drawn from the hazard profiling process for Apex, including the PRI results and input from the Regional Work Groups and Coordinating Committee, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table A.34**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Apex. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment* and below in Section A.3. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE A.34: CONCLUSIONS ON HAZARD RISK FOR APEX

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Nuclear Accident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

A.3 TOWN OF APEX VULNERABILITY ASSESSMENT

This subsection identifies and quantifies the vulnerability of Apex to the significant hazards previously identified. This includes identifying and characterizing an inventory of assets in the county and assessing the potential impact and expected amount of damages caused to these assets by each identified hazard event. More information on the methodology and data sources used to conduct this assessment can be found in Section 6: *Vulnerability Assessment*.

A.3.1 Asset Inventory

Table A.35 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for Apex (study area of vulnerability assessment).[17]

TABLE A.35: IMPROVED PROPERTY IN APEX

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Apex	13,428	$4,077,109,333	11,097	$2,987,895,360

Table A.36 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in Apex. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. In addition, a list of secondary facilities was created to recognize the importance of these facilities in the event of a disaster. These facilities were not mapped, but it is important to recognize that they could be potentially impacted by nearly any of the identified hazards, especially those that are atmospheric or have no specific spatial delineation.

All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure A.10** shows the locations of the primary critical facilities in Wake County. **Table A.48**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility. As noted previously, this list is not all-inclusive and only includes information provided by the local government.

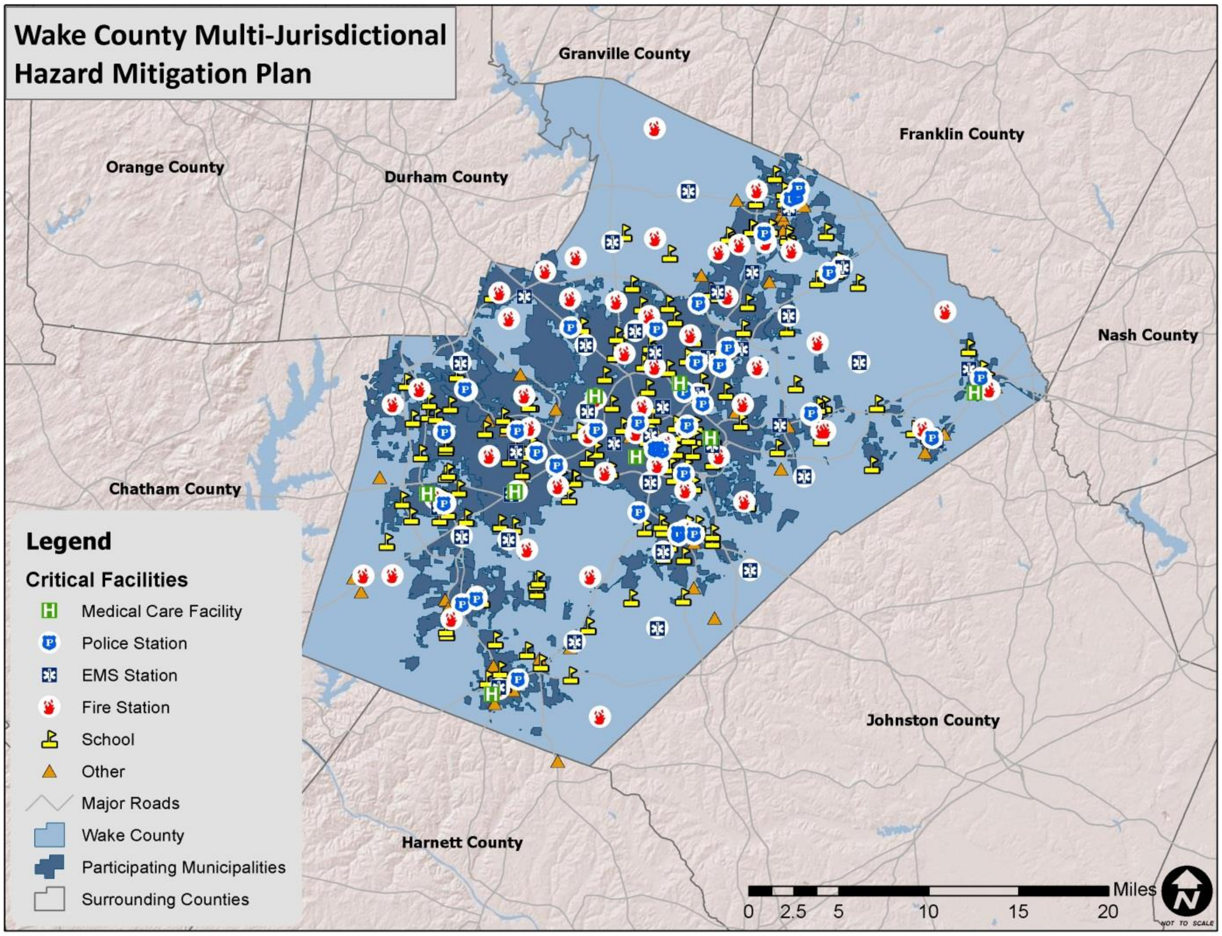
TABLE A.36: CRITICAL FACILITY INVENTORY IN APEX

Location	Fire Stations	Police Stations	EMS Stations	Medical Care Facilities	Schools	Other
Apex	4	1	2	1	10	4

Source: Local Governments

[17] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

FIGURE A.10: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: Local Governments

A.3.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Apex that are potentially at risk to these hazards.

Table A.37 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, limited the results to county-wide estimates. The total population in Apex according to Census data is 37,476 persons. Additional population estimates are presented above in Section A.1.

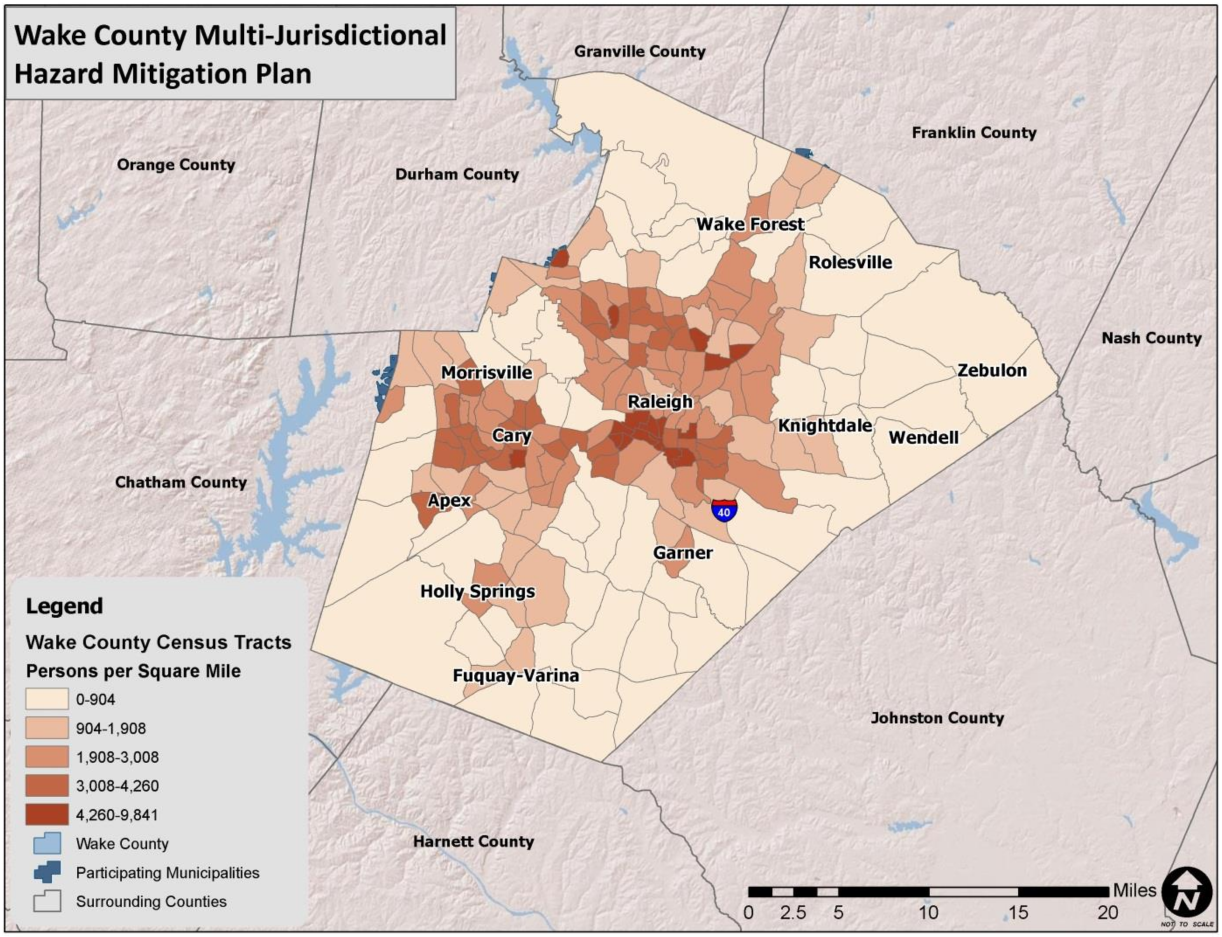
TABLE A.37: TOTAL POPULATION IN APEX

Location	Total 2010 Population
Apex	37,476

Source: U.S. Census 2010

In addition, **Figure A.11** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[18]

FIGURE A.11: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

A.3.3 Vulnerability Assessment Results

As noted in Section 6: *Vulnerability Assessment*, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results, specific to Apex, are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total county exposure, and thus risk, was presented in **Table A.35**.

The annualized loss estimate for all hazards is presented at the end of this section in **Table A.47.**

The hazards presented in this section include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

[18] Population by census block was not available at the time this plan was completed.

Hurricane and Tropical Storm

Historical evidence indicates that Apex has a significant risk to the hurricane and tropical storm hazard. Several tracks have come near or traversed through the county, as shown and discussed in Section A.2.4.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes, and high winds and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table A.38.** Only losses to buildings are reported, in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE A.38: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table A.39.**

TABLE A.39: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Apex	74.2	83.4	102.3	109.0

Source: Hazus-MH 2.1

Social Vulnerability

Given equal susceptibility across the county, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Apex, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table A.48** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Apex. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

Earthquake

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table A.40** summarizes the findings.

TABLE A.40: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability

It can be assumed that all existing future populations are at risk to the earthquake hazard.

Critical Facilities

The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table A.48**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Apex. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

Landslide

In order to complete the vulnerability assessment for landslides in Apex, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section A.2.10), tax parcel and building footprint data, and GIS analysis. **Table A.41** presents the potential at-risk property where available. All areas of Apex are identified as low or moderate incidence areas by the USGS landslide data. Some areas are also of moderate landslide susceptibility. Since there were no high incidence levels in the county, the moderate incidence level was used to identify different areas of concern for the analysis below.

TABLE A. 41: TOTAL POTENTIAL AT-RISK PARCELS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	**Moderate**		
Apex	12,673	10,548	$2,866,496,753

Source: USGS

Social Vulnerability
Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides. However, Apex is probably at somewhat higher risk than other jurisdictions.

Critical Facilities
All critical facilities are located in a moderate susceptibility area. This includes 2 EMS stations, 5 fire stations, 1 medical care facility, 1 police station, 10 schools, and 4 others. A list of specific critical facilities and their associated risk can be found in **Table A.48** at the end of this section.

In conclusion, a landslide has the potential to impact existing and future buildings, facilities, and populations in Apex, though some areas are at a higher risk than others due to a variety of factors. For example, steep slopes and modified slopes bear a greater risk than flat areas. Specific vulnerabilities for county assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

Flood
Historical evidence indicates that Apex is susceptible to flood events. A total of 2 flood events have been reported by the National Climatic Data Center resulting in $0 in damages. On an annualized level, these damages amounted to $0 for Apex.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for the county. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table A.42** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

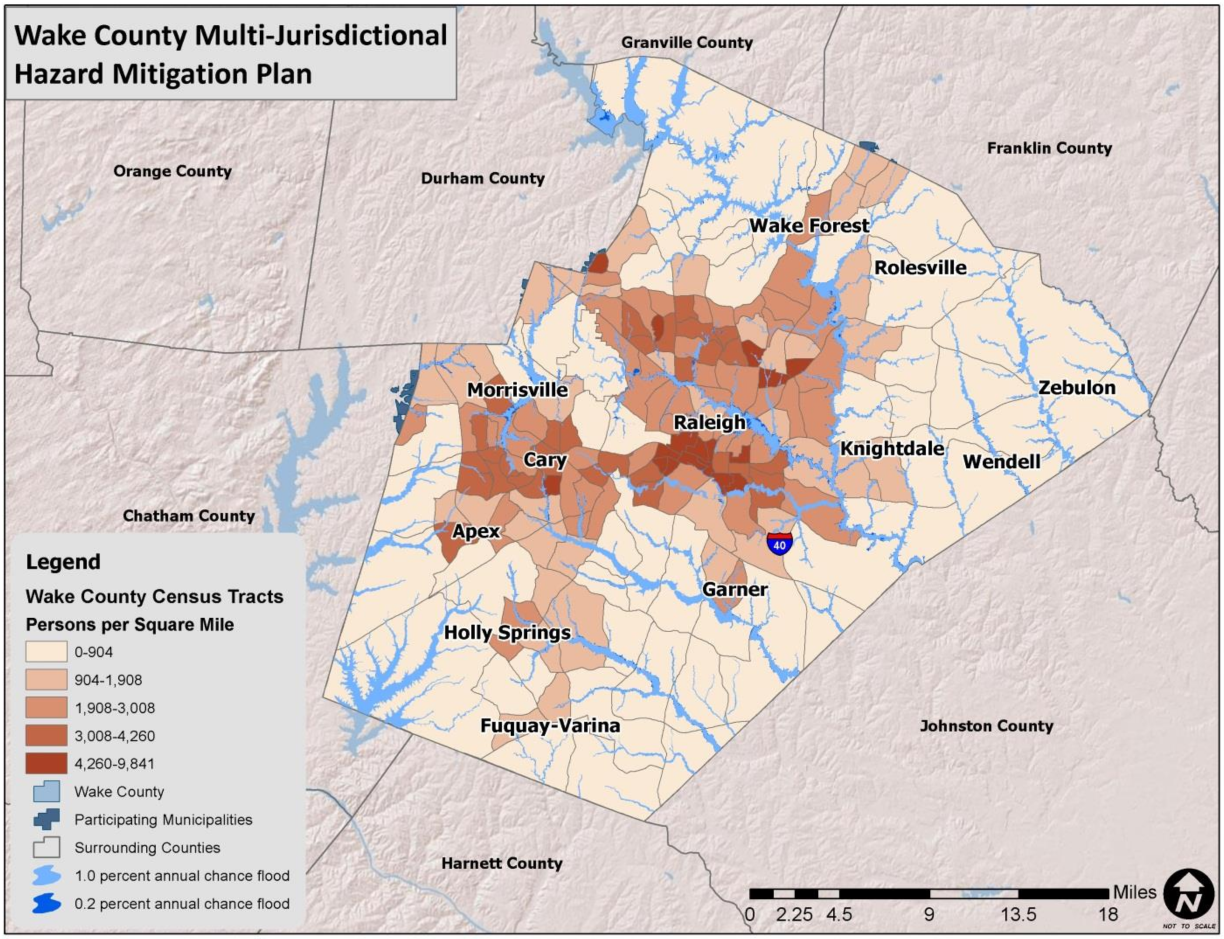
TABLE A.42: ESTIMATED EXPOSURE OF PARCELS TO THE FLOOD HAZARD

Location	1.0-percent ACF			0.2-percent ACF		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings
Apex	258	66	$76,530,969	9	5	$2,280,162

Source: FEMA DFIRM

Social Vulnerability
Since 2010 population was available at the tract level, it was difficult to determine a reliable figure on population at-risk to flood due to tract level population data. **Figure A.12** is presented to gain a better understanding of at risk population.

FIGURE A.12 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities

The critical facility analysis revealed that there are a no critical facilities located in the Apex 1.0-percent annual chance floodplain and 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. A list of specific critical facilities and their associated risk can be found in **Table A.48** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings and populations in Apex, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

Hazardous Materials Incident

Although historical evidence and existing Toxic Release Inventory sites indicate that Apex is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Apex.

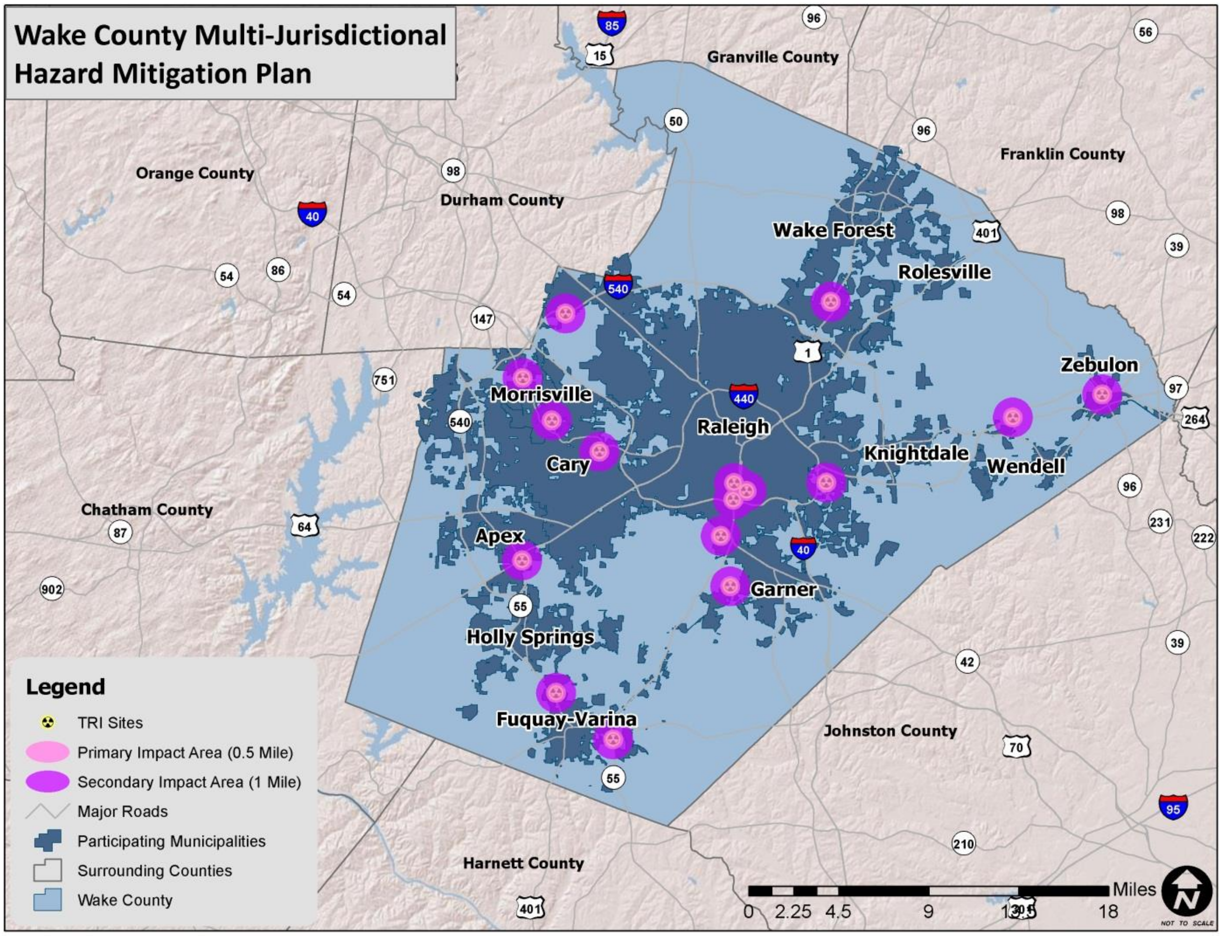
One significant hazardous materials event to impact Apex occurred on October 2, 2006 when the EQ Industrial Services (a hazardous waste handling company) exploded. The event displaced 17,000 citizens and lasted for three days.

Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[19] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Apex, along with buffers, were used for analysis as shown in **Figure A.13.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the GIS buffer analysis. **Figure A.14** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table A.43** (fixed sites), **Table A.44** (mobile road sites) and **Table A.45** (mobile railroad sites).[20]

[19] This type of analysis will likely yield inflated results (generally higher than what is actually reported after an event).
[20] Note that parcels included in the 1.0-mile analysis are also included in the 0.5-mile analysis.

FIGURE A.13 : TRI SITES WITH BUFFERS IN APEX



Source: EPA

TABLE A.43: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Apex	51	121	$69,775,580	695	706	$234,545,987

FIGURE A.14 : MOBILE HAZMAT BUFFERS IN APEX

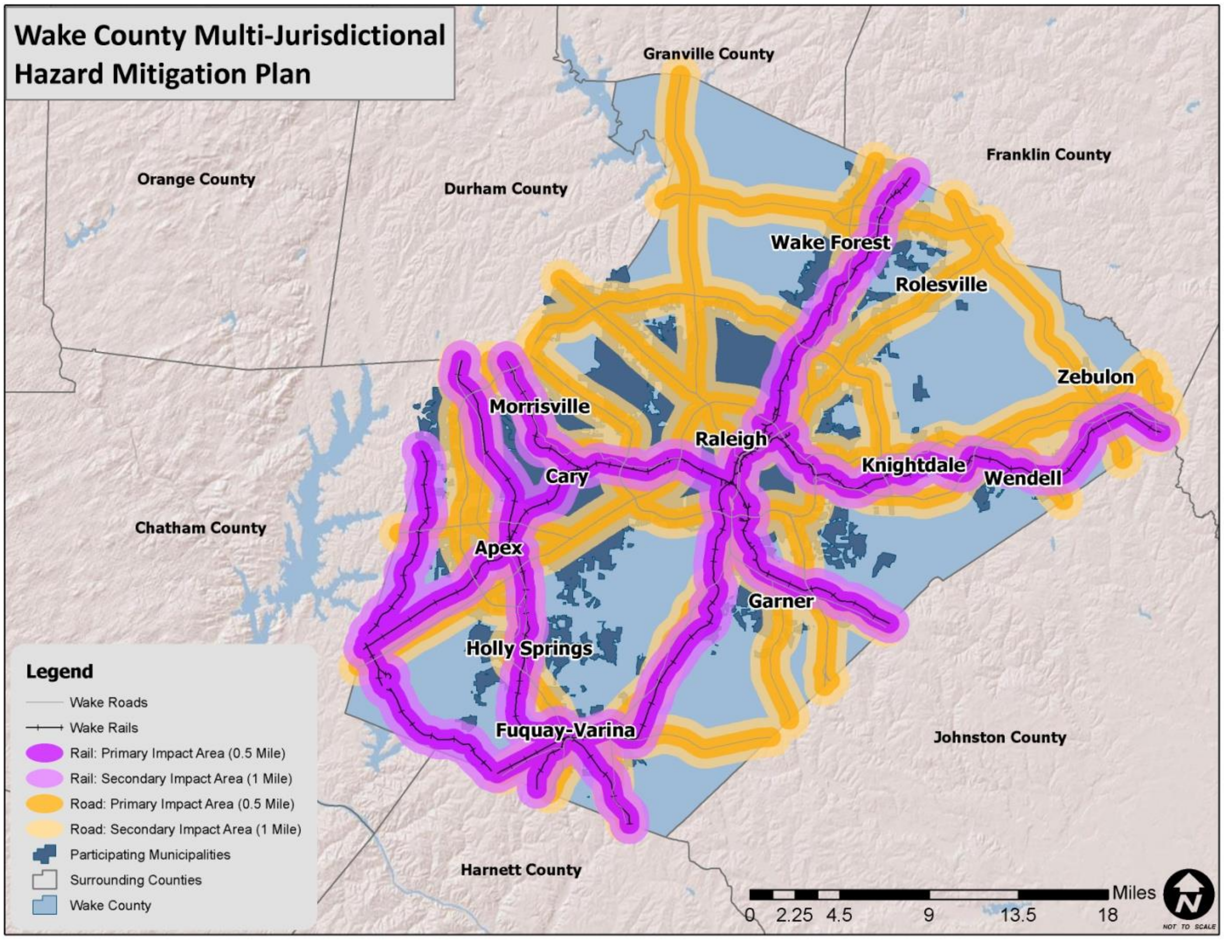


TABLE A.44: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Apex	8,594	7,334	$2,097,748,678	13,001	10,839	$2,918,031,327

TABLE A.45: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Apex	4,970	3,739	$971,882,327	8,489	6,589	$1,801,300,511

Social Vulnerability

Given high susceptibility across the jurisdiction, it is assumed that the total population is at risk to a hazardous materials incident. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities

Fixed Site Analysis:

The critical facility analysis for fixed TRI sites revealed that 4 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes just 1 facility, a water reclamation facility. The remaining facilities are in the secondary, 1.0-mile zone. A list of specific critical facilities and their associated risk can be found in **Table A.48** at the end of this section.

Mobile Analysis:

The critical facility analysis for road and railroad transportation corridors in Apex revealed that there are 20 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 17 facilities. The remaining facilities are in the secondary, 1.0-mile zone. The railroad buffer areas include 19 facilities with 18 in the primary impact zone. It should be noted that many of the facilities located in the buffer areas for railroad are also located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table A.48** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Apex. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc. Further, incidents from neighboring jurisdictions could also have an impact.

Wildfire

Although historical evidence indicates that Apex is susceptible to wildfire events, there are few reports of damage. Upon conversion of the wildfire risk data (see Section 6: *Vulnerability Assessment*) and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the jurisdiction should be assumed to be very low. As such, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the county.

Social Vulnerability

All areas have relatively equal vulnerability and there is low susceptibility across the entire county.
It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in wildfire areas of concern. It should be noted, however, that several factors could impact the spread of a wildfire putting all facilities at risk. A list of specific critical facilities and their associated risk can be found in **Table A.48** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Apex.

Nuclear Accident

The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table A.46** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE A.46: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[21]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[22]
Apex	12,107	9,794	$2,617,633,591	13,428	11,097	$2,987,895,360

Social Vulnerability

Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities

The critical facility analysis revealed that there are a total of eighteen critical facilities located in the 10-mile nuclear buffer area including 2 EMS stations, 3 fire stations, 1 police station, 1 medical care facility, 7 schools, and 4 others in Apex.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in Apex, though areas closer to the power plant are at a higher risk than others. All structures are at some risk given that they are all located within at least the 50-mile buffer area.

Conclusions on Hazard Vulnerability

Table A.47 presents a summary of annualized loss for each hazard in Apex. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, although an annualized loss was determined through the

[21] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.

[22] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

damage reported through historical occurrences at the municipal level, it is likely that the county-wide estimate (found in Section 6: *Vulnerability Assessment*) is potentially a better estimate. These values should be used as an additional planning tool or measure risk for determining hazard mitigation strategies.

TABLE A.47: ANNUALIZED LOSS FOR APEX*

Event	Apex
Dam Failure	Negligible
Drought	Negligible
Erosion	Negligible
Extreme Heat	Negligible
Hail	Negligible
Hurricane & Tropical Storm	Negligible
Landslide	Negligible
Lightning	$4,785
Thunderstorm Wind/High Wind[23]	$2,567
Tornado	Negligible
Winter Storm & Freeze	Negligible
Flood	Negligible
Earthquake	Negligible
HAZMAT Incident	Negligible
Wildfire	Negligible
Nuclear Accident	Negligible
Terror Threat	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table A.48** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

[23] The annualized losses for these hazards were combined.

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TABLE A.48: AT-RISK CRITICAL FACILITIES IN APEX

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
APEX																								
APEX MAIN	EMS STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
APEX SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X		X				X	X	X	X	X		X	X	X
APEX #1	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
APEX #2	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
APEX #3	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X		X		X	X	X
APEX #4	FIRE STATION	X	X	X	X	X	X	X	X	X		X				X	X	X	X	X		X	X	X
WAKEMED HEALTHPLEX	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X		X					X	X				X	X	X
TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X		X						X	X	X		X	X	X
PUBLIC WORKS	OTHER	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
WATER RECLAMATION FACILITY	OTHER	X	X	X	X	X	X	X	X	X		X			X	X	X	X	X	X		X	X	X
WATER TREATMENT PLANT	OTHER	X	X	X	X	X	X	X	X	X		X						X	X	X		X	X	X
APEX	POLICE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
APEX ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
APEX HS	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
OLIVE CHAPEL ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X				X	X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
APEX MS	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
BAUCOM ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
LUFKIN ROAD MS	SCHOOL	X	X	X	X	X	X	X	X	X		X				X	X	X	X	X		X	X	X
SALEM ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
SALEM MS	SCHOOL	X	X	X	X	X	X	X	X	X		X						X	X	X			X	X
APEX FRIENDSHIP HS	SCHOOL	X	X	X	X	X	X	X	X	X		X							X	X		X	X	X
SCOTTS RIDGE ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X		X		X	X	X

Secondary Critical Facilities are listed in slight contrast to Critical Facilities as their continued function has not been deemed as critical as primary facilities in the event of a disaster, but these facilities are extremely important. A loss of function to one of these facilities would have a definitively greater negative impact on the community's ability to respond to and recover from a disaster than a loss of function at other facilities/structures within the jurisdiction. In **Table A.49**, these facilities have been classified as either Significant Community Locations/Sheltering Centers or as Critical Resources Management Facilities. These facilities are all vulnerable to any of the atmospheric hazards and many are also likely vulnerable to other hazards identified above, though no locational analysis was carried out to this end.

TABLE A.49: APEX SECONDARY CRITICAL FACILITIES

Facility Name	Address*	Type
Apex		
US Post Office	501 W Williams Street	Significant Community Location or Sheltering Center
Dixie Pipeline	1521 E Williams Street	Critical Resources Management (Energy, Water, etc.)
Colonial Pipeline	2200 Ten Ten Road	Critical Resources Management (Energy, Water, etc.)
Motiva Enterprises (refinery)	2232 Ten Ten Road	Critical Resources Management (Energy, Water, etc.)
PSNC High Pressure Station	401 N Mason Street	Critical Resources Management (Energy, Water, etc.)
Gas Pipelines	Dixie, Cardinal, and Colonial	Critical Resources Management (Energy, Water, etc.)
Duke Energy Electric Substations	1324 Wimberly Road; 1406 E Williams Street	Critical Resources Management (Energy, Water, etc.)
Community Center	53 Hunter Street	Significant Community Location or Sheltering Center
Halle Cultural Arts Center	237 N Salem Street	Significant Community Location or Sheltering Center
Cox Airport NC81	off Fern Valley Lane	Significant Community Location or Sheltering Center
John Hertrick [Deck] Air Park	off Air Park Drive	Significant Community Location or Sheltering Center
St. Mary Magdalene Catholic School	625 Magdala Place	Significant Community Location or Sheltering Center
Thales Academy	1177 Ambergate Station	Significant Community Location or Sheltering Center
Eva Perry Regional Library	2100 Shepherds Vineyard Drive	Significant Community Location or Sheltering Center
CC Jones Memorial Park	309 Holleman Street	Significant Community Location or Sheltering Center
NC Department of Corrections	2211 Schieffelin Road	Significant Community Location or Sheltering Center
Chemical Feed Station	1907 Laura Duncan Road	Critical Resources Management (Energy, Water, etc.)
Apex Sanitary Landfill (closed 1976)	451 W Williams Street	Critical Resources Management (Energy, Water, etc.)
Cooper Industries	1000 Lufkin Road	Critical Resources Management (Energy, Water, etc.)
Sorrells Landfill (closed 1994)	5013 Jessie Drive	Critical Resources Management (Energy, Water, etc.)
Water Meter Vaults	• E Williams Street & Sunset Lake Road • Dixie Pipeline • 840 US 64 Highway W • Behind 1040 Vision Drive • 4 Vaults on Eyam Hall Lane • W Williams Street & Jenks Road • The Columns at Broadstone connection to	Critical Resources Management (Energy, Water, etc.)

Facility Name	Address*	Type
	Walmart • 3 Vaults on Creek Glen Way • Olive Chapel Elementary School	
0.5 MGD Water Tower	411 N Mason Street	Critical Resources Management (Energy, Water, etc.)
1.0 MGD Water Tower	91 Hunter Street	Critical Resources Management (Energy, Water, etc.)
1.5 MGD Water Tower	610 Tingen Road	Critical Resources Management (Energy, Water, etc.)
Electric Substation	920 Public Power Drive (formerly accessed from E Williams Street)	Critical Resources Management (Energy, Water, etc.)
Electric Substation	2040 Laura Duncan Road	Critical Resources Management (Energy, Water, etc.)
Electric Substation	2300 Mt. Zion Church Road	Critical Resources Management (Energy, Water, etc.)
Pump Stations	• 1701 ½ Kelly Road (located at 1705 Kelly Road) • 730 ½ Tingen Road (Apex Elementary School) • 1232 ½ Perry Road (1300 Block of Shackleton Road) • 2499 ½ Schieffelin Road • 2422 ½ Watersglen Drive (between 2507 and 2509 Watersglen Drive) • 1016 ½ Camberley Drive • 2025 ½ Production Drive (south of 2026 Production Drive) • 1600 ½ Nasturtium Drive • 4251 ½ Sunset Lake Road (out of sequence) • 6010 Old Smithfield Road • 2525 ½ Lake Pine Road (1800 Block) • 2131 ½ Old Raleigh Road • 1000 ½ East Sterlington Place • 2525 ½ Laura Duncan Road (behind 2209 Candun Drive) • 2731 ½ US 64 Highway West • 814 Homestead Park Drive • 411 ½ Blushing Rose Way • 2080 Laura Duncan Road • 1599 Beaver Creek Commons Drive • 2990 Broadstone Way • 2916 Olive Chapel Road (Town of Cary/Western Wake Partners – Beaver Creek Pump Station) • 3905 Green Level West Road (Town of Cary/Western Wake Partners – West Cary	Critical Resources Management (Energy, Water, etc.)

Facility Name	Address*	Type
	Pump Station) Underlined addresses will need to be re-assigned – see parentheses for explanations	

**Some address information could not be provided or was not applicable to the facility*

A.4 TOWN OF APEX CAPABILITY ASSESSMENT

This subsection discusses the capability of the Town of Apex to implement hazard mitigation activities. More information on the purpose and methodology used to conduct the assessment can be found in Section 7: *Capability Assessment*.

A.4.1 Planning and Regulatory Capability

Table A.50 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the Town of Apex. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE A.50: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning Tool/Regulatory Tool	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan (Parks & Rec/Greenway Plan	Stormwater Management Plan/Ordinance	Natural Resource Protection Plan	Flood Response Plan	Emergency Operations Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	National Flood Insurance Program (NFIP)	NFIP Community Rating System
Apex	✓	✓		✓	✓			✓				✓			✓	✓	✓	✓		✓	✓	✓	

A more detailed discussion on the town's planning and regulatory capabilities follows.

Emergency Management

Hazard Mitigation Plan
The Town of Apex has previously adopted a hazard mitigation plan.

Emergency Operations Plan
The Town of Apex has adopted the Wake County Emergency Operations Plan. The town also maintains a municipal-level emergency operations plan.

General Planning

Comprehensive Land Use Plan
The Town of Apex has adopted the *Peak Plan 2030 Comprehensive Plan* as well as a growth management plan.

Capital Improvements Plan
The Town of Apex has a long-range capital improvement program plan in place.

Zoning Ordinance
The Town of Apex includes zoning regulations as part of the local unified development ordinance.

Subdivision Ordinance
The Town of Apex also includes subdivision regulations as part of the local unified development ordinance.

Building Codes, Permitting, and Inspections
North Carolina has a state compulsory building code which applies throughout the state. The building code is enforced within the town's planning jurisdiction by the Town of Apex Building Inspections and Permits Department.

Floodplain Management

Table A.51 provides NFIP policy and claim information for the Town of Apex.

TABLE A.51: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
Apex	03/20/92	04/16/07	90	$25,797,600	0	$0

Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Flood Damage Prevention Ordinance
All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. The Town of Apex participates in the NFIP and has adopted flood damage prevention regulations.

Open Space Management Plan
The Town of Apex has adopted a parks, recreation, greenways, and open space master plan.

Stormwater Management Plan
The Town of Apex has not adopted a stormwater management plan; however, the town includes stormwater management regulations as part of the local unified development ordinance.

A.4.2 Administrative and Technical Capability

Table A.52 provides a summary of the capability assessment results for the Town of Apex with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in the town with the specified knowledge or skill.

TABLE A.52: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	Planners with knowledge of land development/land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency Manager	Floodplain Manager	Land Surveyors	Scientists familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Resource development staff or grant writers
Apex	✓	✓	✓	✓	✓		✓	✓	✓	

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

A.4.3 Fiscal Capability

Table A.53 provides a summary of the results for the Town of Apex with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plan.

TABLE A.53: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes (or taxing districts)	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.
Apex	✓	✓	✓	✓	✓		✓	✓	✓	✓

A.4.4 Political Capability

The previous hazard mitigation plan indicates that the citizens, property owners, business owners, and elected officials of the Town of Apex are committed to improving the community through hazard mitigation. The Mayor along with the Town Council and Town Manager continually strive to make the Town of Apex a safer community in which to live and work. These officials see the hazard mitigation plan as a key component in helping to achieve that goal.

A.4.5 Conclusions on Local Capability

Table A.54 shows the results of the capability assessment using the designed scoring methodology described in Section 7: *Capability Assessment*. The capability score is based solely on the information found in existing hazard mitigation plan and readily available on the town's government website. According to the assessment, the local capability score for the town is 41, which falls into the high capability ranking.

TABLE A.54: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
Apex	44	High

A.5 TOWN OF APEX MITIGATION STRATEGY

This subsection provides the blueprint for Apex to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Regional Work Groups and the findings and conclusions of the capability assessment and risk assessment. Additional Information can be found in Section 8: *Mitigation Strategy* and Section 9: *Mitigation Action Plan*.

A.5.1 Mitigation Goals

Apex developed seven mitigation goals in coordination with Wake County and the other participating municipalities. The county-wide mitigation goals are presented in **Table A.55**.

TABLE A.55: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

A.5.2 Mitigation Action Plan

The mitigation actions proposed by Apex are listed in the following Mitigation Action Plan.

Town of Apex Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Adoption of the Comprehensive Land Use Plan that will provide a 20 year plan for the town and include goals and policies for public safety and hazard mitigation.	All	High	Apex Planning	Local	Completed	Completed 2004. In addition, a Western Area Plan was approved in 2008. The Land Use Map was updated in 2013. This action will be removed from the next update as a capability.
P-2	Land Use Plan (long-range): As town grows towards Jordan Lake, lower density and cluster development. The HMP was reviewed with considerations made for density and cluster development while drafting the plan updates in 2004, 2008, and 2013.	All	Moderate	Apex Planning	Local	Completed	Completed 2004, 2008, and 2013. In 2013, the Land Use Map 2030 increased the density of some areas adjacent to Army Corp Land. (Apex is determining how many acres increased). In addition, the Land Use Map removed land south of Hwy 1 (Apex GIS is determining how many acres). This action will be removed from the next update as a capability.
P-3	UDO: Continue to provide stream and creek buffers, and floodplain and wetland protection. HMP considerations incorporated into the UDO process.	Flood	High	Apex Planning	Local	Completed	UDO continues to provide stream and creek buffers, floodplain, and wetland protection. This action will be removed from the next update as a capability.
P-4	UDO: Resource Conservation Areas (RCA) – Continue to protect floodplains, streams, and creeks. HMP considerations incorporated into the UDO process.	Flood	High	Apex Planning	Local	Completed	UDO RCA continues to protect floodplains, streams, and creeks. This action will be removed from the next update as a capability.
P-5	UDO: Subdivision Standards – Continue to provide protection for residential areas by not allowing residential lots in the floodplain. HMP considerations incorporated into the UDO process.	Flood	High	Apex Planning	Local	Completed	UDO (adopted in 2000) does not allow residential lots within floodplain. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-6	Building Code – Ensure buildings are minimum 2' above base flood elevation. HMP considerations incorporated into the UDO process.	Flood	High	Apex Construction Management	Local	Completed	Building Code, ensure buildings are minimum 2 feet above base flood elevation. This action will be removed from the next update as a capability.
P-7	UDO: Flood Damage Prevention Overlay District – Continue to restrict and prohibit uses which are dangerous to health, safety, and property. Uses vulnerable to floods are protected. HMP considerations incorporated into the UDO process. HMP considerations incorporated into the UDO process.	Flood	High	Apex Planning, Apex Construction Management (Floodplain Manager)	Local	Completed	UDO Section 6. Flood Damage Prevention Overlay District. This action will be removed from the next update as a capability.
P-8	UDO: Flood Damage Prevention – Ensure control is provided for filling, grading and dredging within floodplains by working with necessary State and Federal Agencies. HMP considerations incorporated into the UDO process.	Flood	Moderate	Apex Planning, Apex Construction Management	Local	Completed	Flood Damage Prevention Ordinance. This action will be removed from the next update as a capability.
P-9	UDO: Flood Damage Prevention – prevent or regulate construction of flood barriers. HMP considerations incorporated into the UDO process.	Flood	Moderate	Apex Construction Management	Local	Completed	Flood Damage Prevention Ordinance. This action will be removed from the next update as a capability.
P-10	UDO: Watershed Protection Overlay District – Ensure riparian buffers are provided for perennial and intermittent streams, lakes, and ponds. HMP considerations incorporated into the UDO process.	Flood	High	Apex Planning, Apex Public Works and Utilities	Local	Completed	Watershed Protection Overlay District. This action will be removed from the next update as a capability.
P-11	UDO 7.2.1 - Streets – Ensure road standards to be maintained in disaster preparation for possible use as evacuation routes. Amendments to the Transportation Plan included street standards and interconnectivity for possible use in routing. HMP considerations incorporated into the UDO process.	All	Moderate	Apex Planning	Local	Completed	UDO and Transportation Plan. Road standards and interconnectivity. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-12	Provide adequate water supply through storage and interconnection with other public water systems.	Drought	Moderate	Apex Public Works and Utilities	Local	Completed	The town works with surrounding municipalities and the county to ensure an adequate water supply. This action will be removed from the next update as a capability.
P-13	Provide adequate electric utility service through tree trimming contracts, the use of six circuits, and the construction of a new electrical substation.	All	Moderate	Apex Public Works and Utilities	Local	Completed	Public Works has its own Tree Trimming crew with Arborists. This action will be removed from the next update as a capability.
P-14	Provide backup power for all critical public facilities (wastewater treatment plant, sewer pump stations, Public Works and Utilities building, and other critical public buildings).	All	Moderate	Apex Public Works and Utilities	Local	Completed	Critical public buildings have backup power. This action will be removed from the next update as a capability.
P-15	Maintain major town transportation routes through snow and ice removal contracts and equipment.	Severe Winter Storms	Moderate	Apex Public Works and Utilities	Local	Completed	Public Works included a salt/sand container in 2012. This action will be removed from the next update as a capability.
P-16	Require Engineered Storm Water Control Structures.	Flood	Moderate	Apex Public Works and Utilities	Local	Completed	The town continues to evaluate locations for stormwater control structures and has installed some of these structures in the past. This action will be removed from the next update as a capability.
P-17	Back-up information pertaining to Town government in case of an emergency.	All	Moderate	Apex Information Technology	Local	Completed	Town of Apex on a regular basis backs-up information pertaining to Town government in case of an emergency. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-18	Apex Transportation Plan – Continue to address disaster preparedness (evacuation) through road interconnectivity, paved roads, and widening of roads.	All	Moderate	Apex Planning	Local	Completed	Amendments to the Transportation Plan included street standards and interconnectivity for possible use in routing. This action will be removed from the next update as a capability.
P-19	Review and update as necessary UDO Flood Damage Prevention Overlay District regulations to increase protection from flood hazard events.	Flood	Moderate	Apex Planning	Local	Completed	The UDO Flood Damage Prevention Overlay District needs to be reviewed and updated regularly. This action will be removed from the next update as a capability.
P-20	Develop adverse Weather Plan Map for Public Works Work Crew.	All	High	Apex Construction Management	Local	Completed	The Adverse Weather Plan Map has been developed. This action will be removed from the next update as a capability.
P-21	Adopt FEMA's new FIRM.	Flood	High	Apex Planning	Federal	Deleted	Deleted. Item is redundant and P-26 suffices.
P-22	Adopted additional Title 44 Federal Regulations to the Unified Development Ordinance.	Flood	High	Apex Planning	Federal	Completed	Completed 2006. Adopted additional Title 44 Federal Regulations to the UDO. This action will be removed from the next update as a capability.
P-23	Adopted additional Chapter 143 NC General Statutes regarding floodway regulation.	Flood	High	Apex Construction Management	State	Completed	Completed. Adopted additional Chapter 143 NC General Statutes to the UDO. This action will be removed from the next update as a capability.
P-24	Implemented new Floodplain Development Permit.	Flood	High	Apex Construction Management	Local	Completed	Completed. A new floodplain development permit has been implemented for use in the town. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-25	Maintain Continuing Education Training for maintenance of Floodplain Management Certificate (16 hours).	Flood	High	Apex Construction Management	Local	Completed	Completed every 2 years by Floodplain Manager. This action will be removed from the next update as a capability.
P-26	FEMA Flood Map updates and Flood Plain Manager Certification.	Flood	High	Apex Construction Management	Local	Deleted	Delete. Similar to P-21 and P-25
P-27	Develop FEMA Debris Management Plan.	All	High	Apex Public Works and Utilities	Local	Completed	The Debris Management Plan has been developed so this action is completed. This action will be removed from the next update as a capability.
P-28	Allow fill but no structures within the Floodplain.	Flood	High	Apex Planning, Apex Construction Management (Floodplain Manager)	Local	Completed	Revised April 2012. Changed from “proposed no construction tilling within the Floodplain.” This action will be removed from the next update as a capability.
P-29	Created new Transportation Planner position.	All	High	Apex Planning	Local	Completed	Completed 2006. Apex plans on retaining a Transportation Planner. This action will be removed from the next update as a capability.
P-30	Coordinate Transportation Planning with CAMPO.	All	High	Apex Planning	Local	Completed	The town coordinates regularly with CAMPO on Transportation Planning. This action will be removed from the next update as a capability.
P-31	Revise and update regulatory floodplain maps.	Flood	Moderate	Apex Construction Management (Floodplain Manager)	Local	2017	New action.
P-32	Designate a local floodplain manager and/or CRS coordinator who achieves CFM certification.	Flood	Moderate	Apex Construction Management (Floodplain Manager)	Local	2015	New action.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-33	Develop an environmental committee that meets regularly to discuss issues and recommend projects.	Flood, Drought, Erosion, Wildfire, Landslide	Moderate	Apex Public Works (Environmental Program Director)	Local	2015	New action.
P-34	Form a citizen plan implementation steering committee to monitor progress on local mitigation actions. Include a mix of representatives from neighborhoods, local businesses, and local government.	Flood	Moderate	Apex Public Works (Environmental Program Director)	Local	5 years	New action.
P-35	Encourage the use of Low Impact Development techniques.	Flood	Low	Apex Public Works (Environmental Program Director)	Local	5 years	New action.
P-36	Encourage the use of porous pavement, vegetative buffers, and islands in large parking areas.	Flood	Low	Apex Public Works (Environmental Program Director)	Local	5 years	New action.
P-37	Encourage the use of permeable driveways and surfaces to reduce runoff and promote groundwater recharge.	Drought, Flood	Low	Apex Public Works (Environmental Program Director)	Local	5 years	New action.
P-38	Use impact fees to help fund public projects to mitigate impacts of land development.	Flood	Moderate	Apex Public Works (Environmental Program Director)	Local	5 years	New action.
P-39	UDO update: incorporate proper specials selection, planting, and maintenance practices into landscape ordinance.	All	Moderate	Apex Planning	Local	2017	New action.
P-40	Obtain local data including tax parcels, building footprints, critical facility locations, and other information for use in risk analysis.	All	Moderate	Apex GIS, Apex Construction Management	Local	2015	New action.
P-41	Incorporate a GIS system/management plan for tracking permitting and land use patterns.	All	Moderate	Apex GIS	Local	2018	New action.
Property Protection							
PP-1							

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Natural Resource Protection							
NRP-1	UDO 6.1.12 – Continue to require engineered stormwater controls including stream and wetland protection. HMP considerations incorporated into the UDO process.	Flood	Moderate	Apex Planning, Apex Public Works	Local	Completed	UDO continues to require engineered stormwater controls. This action will be removed from the next update as a capability.
NRP-2	UDO 6.2 - Flood Damage Prevention Overlay District - continue to prohibit any development in floodway to protect floodplains and wetlands. HMP considerations incorporated into the UDO process.	Flood	Moderate	Apex Planning, Apex Construction Management	Local	Completed	UDO continues to prohibit any development in the floodway. This action will be removed from the next update as a capability.
NRP-3	Phase 1 C Beaver Creek Greenway – Whitehall to Jaycee.	All	High	Apex Parks and Recreation	Local	Completed	Phase 1 C Beaver Creek Greenway was completed in 2009. This action will be removed from the next update as a capability.
NRP-4	Phase II Haddon Hall Greenway.	All	High	Apex Parks and Recreation	Local	Completed	Phase II Haddon Hall Greenway was completed in 2009. This action will be removed from the next update as a capability.
NRP-5	Phase I Apex Nature Park.	All	High	Apex Parks and Recreation	Local	Completed	Phase I Apex Nature Park was completed in 2011. This action will be removed from the next update as a capability.
NRP-6	Phase II Nature Park.	All	High	Apex Parks and Recreation	Local	Completed	Phase II Nature Park was completed in 2012. This action will be removed from the next update as a capability.
NRP-7	Extend Beaver Creek Greenway (Kelly Road to Nature Park).	All	High	Apex Parks and Recreation	Local	Completed	Completed and Revised. Green infrastructure program to link, manage, and expand existing parks, preserves, and greenways. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-8	Water Shortage Response Plan.	All	High	Apex Public Works and Utilities	Local	Completed	The Water Shortage Response Plan is in place and active. This action will be removed from the next update as a capability.
NRP-9	Adoption of NC Division of Water Quality Best Management Practices Manual for NPDES Phase II Community.	All	High	Apex Public Works and Utilities	Local, State	Completed	Completed. The town has adopted NC DWQ Best Management Practices for Phase II Community. This action will be removed from the next update as a capability.
NRP-10	Adopt erosion and sedimentation control regulations for construction and farming.	Flood, Erosion	Moderate	Apex Construction Management (Floodplain Manager)	Local	2019	New action.
NRP-11	Use stream restoration to ensure adequate drainage and diversion of stormwater.	Flood	Moderate	Apex Public Works (Environmental Program Director)	Local	2019	New action.
NRP-12	Middle Creek Greenway (Miramonte to Holly Springs).	All	Moderate	Apex Parks and Recreation	Local	2019	New action. Green infrastructure program to link, manage, and expand existing parks, preserves, and greenways.
NRP-13	White Oak Creek Greenway.	All	Moderate	Apex Parks and Recreation	Local	2020	New action. Green infrastructure program to link, manage, and expand existing parks, preserves, and greenways.
Structural Projects							
SP-1							
Emergency Services							
ES-1	Ongoing provision of emergency assistance as needed.	All	High	Apex Police, Apex EMS, Apex Fire	Local	Completed	Emergency assistance is provided for as needed. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-2	Emergency Operations Command Post Center – established when natural hazard imminent. If needed, Center coordinates evacuations, sheltering, staging for equipment, manpower, and needed supplies. Equipment includes internet access, telephone, wireless communications, radio and backup supplied by emergency batteries and/or generators.	All	High	Apex Fire, Apex EMS, Apex Police	Local	Completed	Emergency Operations Center has been established in the past when events occur. This will continue to occur in the future. This action will be removed from the next update as a capability.
ES-3	Ensure hazard warning methods include television, radio, internet and, if needed, emergency vehicles loud speaker systems.	All	Moderate	Apex Town Manager's Office	Local	Completed	Hazard warning methods are varied and include many different types of warning systems. These systems are in place. This action will be removed from the next update as a capability.
ES-4	Maintain open lines of communication between all branches of emergency response personnel.	All	Moderate	Apex Fire, Apex EMS	Local	Completed	Open lines of communication between the emergency response personnel are in place. This action will be removed from the next update as a capability.
ES-5	Prepare for emergency situations – weather station, local weather warning system, and emergency management.	All	Moderate	Apex Fire	Local	Completed	Preparations for emergency situations are undertaken prior to an emergency utilizing a number of sources such as weather stations and emergency management. This action will be removed from the next update as a capability.
ES-6	Standard Operating Guidelines – collection of procedures to be followed during emergencies.	All	High	Apex Fire	Local	Completed	Updated Standard Operating Guidelines are in place that explain how the town should act during an emergency situation. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-7	Maintain contact information for local businesses in case of an emergency.	All	High	Apex Fire	Local	Completed	A list of local businesses has been developed. This action will be removed from the next update as a capability.
ES-8	Health and safety maintenance – provide assistance with security and post storm clean-up.	All	High	Apex Police	Local	Completed	During an event, assistance with security and post storm cleanup is provided by the police department. This action will be removed from the next update.
ES-9	Post disaster response – building inspections.	All	Moderate	Apex Construction Management	Local	Completed	After a disaster event, building inspections are carried out to assess damage. This action will be removed from the next update.
ES-10	Town of Apex Fire Department will merge with Apex EMS (formerly private).	All	High	Apex Fire, Apex EMS	Local	Deleted	Deleted. Not completed due to budget concern.
ES-11	Chemical Fire Action Report available on CD.	Fire	High	Apex Fire	Local	Completed	The Chemical Fire Action Report was completed in 2006. This action will be removed from the next update as a capability.
ES-12	Construct Fire Station #4.	Fire	High	Apex Fire	Local	Completed	Fire Station #4 was completed in 2009. This action will be removed from the next update as a capability.
ES-13	Construct Fire Stations #5 and #6.	Fire	Moderate	Apex Fire	Local	2017	Locations for #5 and #6 are still pending so this action is still a work in progress.
ES-14	State Fire Marshall Office Grant – providing smoke detectors to low-income residents.	Fire	High	Apex Fire	State	Completed	The grant has been received and smoke detectors are being distributed. This action will be removed from the next update as a capability.
ES-15	Acquire additional 4 ambulances.	All	High	Apex EMS	Local	Deleted	Not completed due to budget and not merging with Apex EMS.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-16	Community Emergency Response Team (CERT) training available through Fire Department.	All	Moderate	Apex Fire	Local	Completed	CERT training remains available through the Fire Department. This action will be removed from the next update as a capability.
Public Education and Awareness							
PEA-1	Town website - public access, emergency information and contact numbers, link to hurricane and Harris nuclear evacuation route maps and safety information. Revise the Emergency Information Page. Add Ready Wake link.	All	Moderate	Apex Information Public Officer	Local	2015	The town website has been updated with information for public use, but that information should be revised.
PEA-2	Hazard Disclosure – Geographic information systems (GIS) map maintained to increase public awareness of known hazard locations.	Flood	Moderate	Apex Planning	Local	Completed	A GIS map and database for the public is maintained. This action will be removed from the next update as a capability.
PEA-3	Planned park land purchase – nature park to include trails and environmental education center.	Flood	High	Apex Parks and Recreation	Local Wake County	Completed	Completed. Nature Park in operation. This action will be removed from the next update as a capability.
PEA-4	Public Library – Maintain and update hazard information accessible to the public.	All	Moderate	Apex Planning	Local	Within 30 days after HMP update is adopted by Town Council	Through 2014, the town has maintained up to date information on hazards in its public library and will update public library with information on hazards after the plan has been approved and adopted.
PEA-5	Continue to provide flood maps for public use with staff continuing to be available for public assistance.	Flood	High	Apex Planning, Apex Construction Management (Floodplain Manager)	Local	Completed	A flood map for the public is maintained. This action will be removed from the next update as a capability.
PEA-6	Bi-annual update of the Town's website for broken links.	All	Moderate	Apex Information Public Officer	Local	Completed	The town reviews its website for broken links on a bi-annual basis. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-7	National Night Out – Hurricane/Disaster Awareness Open House.	Hurricane	High	Apex Planning, Apex Fire, Apex EMS	Local	Deleted	Deleted. Incorporated under action PEA-17.
PEA-8	Include FEMA flood map link on the Town Website on the Engineering page.	Flood	High	Apex Construction Management (Information Public Officer)	Local	2015	New action.
PEA-9	Town website and utility billing announcing National Preparedness Month (September) reminding citizens to have a plan and be prepared.	All	Moderate	Apex Information Public Officer	Local	2015	New action.
PEA-10	Include Environment Education Station and classroom at Nature Park.	All	Moderate	Apex Parks and Recreation	Local	2019	New action.
PEA-11	Post warning signage at local parks for lightning.	Lightning	Moderate	Apex Parks and Recreation	Local	2019	New action.

Annex B
Town of Cary

This annex includes jurisdiction-specific information for the Town of Cary. It consists of the following five subsections:

- B.1 Town of Cary Community Profile
- B.2 Town of Cary Risk Assessment
- B.3 Town of Cary Vulnerability Assessment
- B.4 Town of Cary Capability Assessment
- B.5 Town of Cary Mitigation Strategy

B.1 TOWN OF CARY COMMUNITY PROFILE

B.1.1 Geography and the Environment

Cary is a town located in Wake County in the State of North Carolina. It was incorporated in 1871 and is the seventh largest municipality in North Carolina.

Overall, Wake County is known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Summer temperatures generally venture into the 90s for highs and cool off to the 70s at night. Winter temperatures in can drop to below freezing but generally highs are in the 50s. Rainfall is most common in the summer months but occurs consistently throughout the year.

B.1.2 Population and Demographics

According to the 2010 Census, Cary has a population of 135,234 people. The jurisdiction has seen exceptional growth between 2000 and 2010, and the population density is over 2,500 people per square mile. Population counts from the US Census Bureau for 1990, 2000, and 2010 are presented in **Table B.1**.

TABLE B.1: POPULATION COUNTS FOR CARY

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
CARY	43,858	94,536	135,234	43.05%

Source: US Census Bureau

The racial characteristics of the jurisdiction are presented in **Table B.2**. Whites make up the majority of the population in the jurisdiction, accounting for nearly 75 percent of the population.

TABLE B.2: DEMOGRAPHICS OF CARY

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
CARY	73.1%	8.0%	0.4%	18.5%	7.2%

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

B.1.3 Housing

According to the 2010 US Census, there are 55,303 housing units in Cary, the majority of which are single family homes or mobile homes. Housing information for the jurisdiction is presented in **Table B.3**.

TABLE B.3: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Seasonal Units, Percent (2010)	Median Home Value (2007-2011)
CARY	36,863	55,303	6.4%	$302,500

Source: US Census Bureau

B.1.4 Infrastructure

Transportation

There are several major roadways that residents of Cary utilize. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs, one of which is I-540/NC-540 which is a partly completed loop that connects the jurisdiction to many of the other municipalities. In addition to the Interstate, there are many major highways that residents of the municipality utilize. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways in the include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities

Electrical power in the jurisdiction is provided by two entities and Duke Energy and Wake Electric Membership Corporation with Duke Energy providing service to a majority of the service. Water and sewer service is provided by two main entities as well: The City of Raleigh Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

Community Facilities

There are a number of buildings and community facilities located throughout Cary. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 10 fire stations, 4 police stations, and 26 public schools located within the jurisdiction There is one medical care facility located in the municipality

Citizens also have access within Cary to twenty- nine park areas and fifteen special use facilities including: three community centers with gyms; one senior center, one tennis park, one national baseball training center, two arts/historical center, two outdoor amphitheatres, a downtown theatre, a boathouse, skate park, soccer park, dog park and approximately 70 miles of greenway and trails. There are three state parks: Falls Lake State Recreation area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the county, including the American Tobacco Trail which is a Rails to Trails project that is open to a wide variety of non-motorized uses.

B.1.5 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land as parks. There are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the jurisdiction consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

B.1.6 Employment and Industry

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

B.2 TOWN OF CARY RISK ASSESSMENT

This subsection includes hazard profiles for each of the significant hazards identified in Section 4: *Hazard Identification* as they pertain to Cary. Each hazard profile includes a description of the hazard's location and extent, notable historical occurrences, and the probability of future occurrences. Additional information can be found in Section 5: *Hazard Profiles*.

B.2.1 Drought

Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, Cary has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that the county would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Historical Occurrences

According to the North Carolina Drought Monitor, Cary has had drought occurrences all of the last fourteen years (2000-2013). **Table B.4** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE B.4: HISTORICAL DROUGHT OCCURRENCES IN CARY

Abnormally Dry **Moderate Drought** **Severe Drought** **Extreme Drought** **Exceptional Drought**

	Cary
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that Cary has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

B.2.2 Extreme Heat

Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to any geographic or political boundaries. All of Cary is susceptible to extreme heat conditions.

Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Cary. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the region. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the county. The most centralized location is in Raleigh at North Carolina State University. **Table B.5** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table B.5: Average Maximum Temperature in Raleigh, Wake County

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

B.2.3 Hailstorm

Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Cary is uniformly exposed to severe thunderstorms; therefore, all areas are equally exposed to hail which may be produced by such storms.

Historical Occurrences

According to the National Climatic Data Center, 22 recorded hailstorm events have affected Cary since 1993.[1] **Table B.6** is a summary of the hail events in Cary. **Table B.7** provides detailed information about each event that occurred. In all, hail occurrences resulted in over $9,000 (2013 dollars) in property damages. Hail ranged in diameter from 0.75 inches to 2.25 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value.

[1] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Cary. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

TABLE B.6: SUMMARY OF HAIL OCCURRENCES IN CARY

Location	Number of Occurrences	Property Damage (2013)
Cary	22	$9,008

Source: National Climatic Data Center

TABLE B.7: HISTORICAL HAIL OCCURRENCES IN CARY

	Date	Magnitude	Deaths/Injuries	Property Damage*
Cary				
Cary	5/19/1993	2.25 in.	0/0	$9,008
Cary	5/19/1993	1.75 in.	0/0	$0
CARY	7/2/1996	0.75 in.	0/0	$0
CARY	6/2/1997	1 in.	0/0	$0
CARY	6/2/1997	0.88 in.	0/0	$0
CARY	3/20/1998	0.75 in.	0/0	$0
CARY	5/7/1998	0.75 in.	0/0	$0
CARY	4/29/2000	0.75 in.	0/0	$0
CARY	4/1/2001	0.75 in.	0/0	$0
CARY	5/12/2001	0.75 in.	0/0	$0
CARY	5/12/2001	0.75 in.	0/0	$0
CARY	5/14/2006	0.75 in.	0/0	$0
CARY	5/14/2006	0.75 in.	0/0	$0
CARY	4/21/2008	0.88 in.	0/0	$0
CARY	5/20/2008	0.75 in.	0/0	$0
CARY	5/20/2008	0.75 in.	0/0	$0
CARY	8/30/2008	1 in.	0/0	$0
CARY	8/29/2011	1 in.	0/0	$0
CARY	3/31/2012	1.75 in.	0/0	$0
CARY	5/23/2012	2 in.	0/0	$0
CARY	7/27/2012	1.75 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that Cary has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the county.

B.2.4 Hurricane and Tropical Storm

Location and Spatial Extent

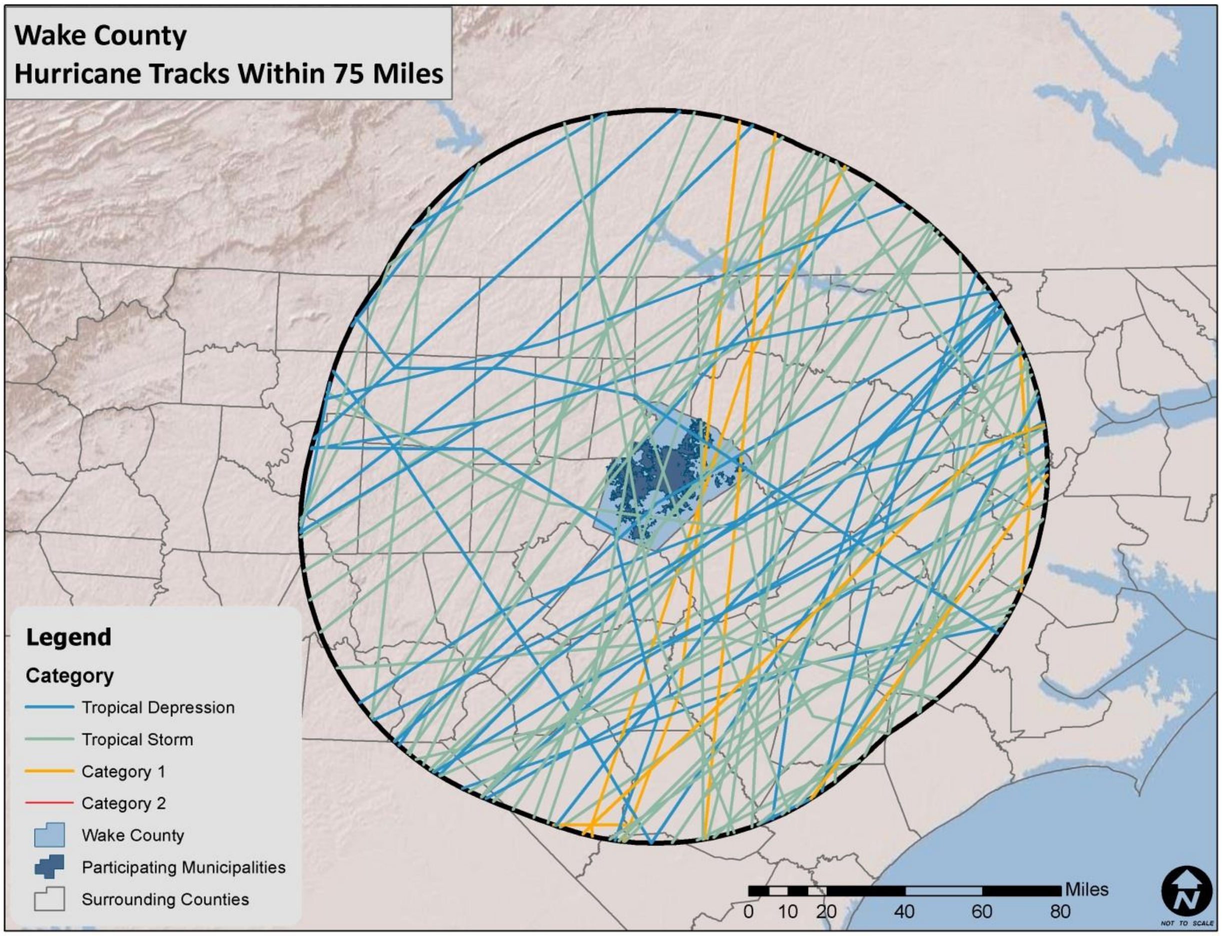
Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Cary. The entire jurisdiction is equally susceptible to hurricane and tropical storms.

Historical Occurrences

According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[2] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms have traversed directly through Wake County as shown in **Figure B.1**. **Table B.8** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

FIGURE B.1: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE B.8: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm

[2] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1
1882	NOT NAMED	53	Tropical Storm
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm
1959	CINDY	26	Tropical Depression
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
2008	HANNA	40	Tropical Storm

Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Cary between 1950 and 2013. These storms are listed in **Table B.9** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE B.9: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made in 1996 (Hurricane Fran), 1999 (Hurricane Floyd), and 2003 (Hurricane Isabel) for the county.[3]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Tropical Storm Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

[3] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

Probability of Future Occurrences

Given the inland location of the jurisdiction, it is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Cary. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the jurisdiction is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

B.2.5 Lightning

Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Cary is uniformly exposed to lightning.

Historical Occurrences

According to the National Climatic Data Center, there have been six recorded lightning events in Cary since 1950, as listed in summary **Table B.10** and detailed in **Table B.11**.[4] However, it is certain that more lightning events have in fact impacted the jurisdiction. Many of the reported events are those that caused damage, and it should be expected that damages are likely much higher for this hazard than what is reported.

TABLE B.10: SUMMARY OF LIGHTNING OCCURRENCES IN CARY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Cary	6	0/0	$133,182

Source: National Climatic Data Center

TABLE B.11: HISTORICAL LIGHTNING OCCURRENCES IN CARY

	Date	Deaths/Injuries	Property Damage*	Details
Cary				
CARY	5/3/1998	0/0	$79,768	A large house was struck by lightning on Gold Meadow Drive in Cary. The strike caused an electrical fire that damaged most of the house. Smoke from the fire produced the most damage.
CARY	9/3/2000	0/0	$0	Lightning struck a house.
CARY	3/7/2005	0/0	$26,095	Lighting struck a tree outside a Cary residence. Lightning then entered

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Cary. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

	Date	Deaths/Injuries	Property Damage*	Details
				the natural gas line rupturing the line under the house resulting in a severely damaging fire.
CARY	2/28/2011	0/0	$5,464	A bowing line segment developed ahead of a strong cold front approaching from the west. Despite very strong deep layer shear, marginal instability resulted in only sporadic |reports of wind damage across central North Carolina.
CARY	2/28/2011	0/0	$5,464	A bowing line segment developed ahead of a strong cold front approaching from the west. Despite very strong deep layer shear, marginal instability resulted in only sporadic |reports of wind damage across central North Carolina.
CARY	7/24/2011	0/0	$16,391	A cluster of shower and thunderstorms moved off the Appalachians and into central North Carolina during the afternoon. The severe storms produced thunderstorm wind damage across the Central Piedmont with minor structural damage to a couple of outdoor buildings.

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Although there were not a high number of historical lightning events reported in Cary via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S. National Lightning Detection Network (NLDN®), Cary is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the jurisdiction.

B.2.6 Severe Thunderstorm/High Wind

Location and Spatial Extent

A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Also, Cary typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Cary has uniform exposure to an event and the spatial extent of an impact could be large.

Historical Occurrences

Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011.[5] According to NCDC, there have been 18 reported thunderstorm/high wind events since 1994 for high wind and since 1950 for thunderstorms.[6] These events caused over $50,000 (2013 dollars) in damages. **Table B.12** summarizes this information. **Table B.13** presents detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event.[7]

TABLE B. 12: SUMMARY OF THUNDERSTORM/HIGH WIND OCCURRENCES IN CARY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Cary	18	0/0	$51,206

Source: National Climatic Data Center

TABLE B.13: HISTORICAL THUNDERSTORM/HIGH WIND OCCURRENCES IN CARY

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Cary					
Cary	8/3/1993	THUNDERSTORM WINDS	0 kts.	0/0	$0
Cary	8/3/1993	THUNDERSTORM WINDS	52 kts.	0/0	$0
Cary	3/21/1995	THUNDERSTORM WINDS	0 kts.	0/0	$51,206
CARY	6/4/1996	TSTM WIND	0 kts.	0/0	$0
CARY	6/30/1998	TSTM WIND	50 kts.	0/0	$0
CARY	8/18/2000	TSTM WIND	50 kts.	0/0	$0
CARY	8/19/2002	TSTM WIND	50 kts.	0/0	$0
CARY	8/19/2002	TSTM WIND	50 kts.	0/0	$0
CARY	1/14/2005	TSTM WIND	50 kts.	0/0	$0
CARY	3/8/2005	TSTM WIND	60 kts.	0/0	$0

[5] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.

[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional thunderstorm events have occurred in Cary. As additional local data becomes available, this hazard profile will be amended.

[7] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
CARY	4/17/2006	TSTM WIND	50 kts.	0/0	$0
CARY	4/22/2006	TSTM WIND	50 kts.	0/0	$0
CARY	8/9/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
CARY	8/21/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
CARY	3/4/2008	THUNDERSTORM WIND	51 kts.	0/0	$0
CARY	7/28/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
CARY	7/30/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
CARY	7/24/2011	THUNDERSTORM WIND	50 kts.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire jurisdiction.

B.2.7 Tornado

Location and Spatial Extent

Tornadoes occur throughout the state of North Carolina, and thus in Cary. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Cary is uniformly exposed to this hazard.

Historical Occurrences

Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there have been two recorded tornado events in Cary since 1956 (**Table B.14**), resulting in nearly $83,000 (2013 dollars) in property damages.[8] Detailed information on this event can be found in **Table B.15**. The greatest magnitude of these tornados was a F0 in intensity, although an F5 event is possible. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is likely that a high number of occurrences have gone unreported over the past 50 years.

TABLE B.14: SUMMARY OF TORNADO OCCURRENCES IN CARY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Cary	2	0/0	$82,869

[8] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Cary. As additional local data becomes available, this hazard profile will be amended.

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)

Source: National Climatic Data Center

TABLE B.15: HISTORICAL TORNADO IMPACTS IN CARY

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Cary					
Cary	7/12/1996	F0	0/0	$82,869	A small tornado formed along an outer band of Hurricane Bertha. The hurricane was centered approximately 140 miles to the southeast. The tornado was on the ground about 6 minutes and moved east to west at 50 mph. Numerous trees were snapped or uprooted. About 10 homes received minor damage due to falling trees.
Cary	6/1/2001	F0	0/0	$0	Siding was blown off of apartment buildings near Highway 54 and Cary Parkway. Trees were also blown down in the area, and a funnel cloud was reported.

*Property Damage is reported in 2013 dollars.
Source: NCDC

2011 Tornadoes- April 16, 2011
In 2011, the county and all of its jurisdictions were impacted by one of the worst tornado-related events in the county's recorded history. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries.

Probability of Future Occurrences
According to historical information, tornado events are not an annual occurrence for the jurisdiction. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Cary experience a direct tornado strike. The probability of future tornado occurrences affecting Cary is likely (10-100 percent annual probability).

B.2.8 Winter Storm and Freeze

Location and Spatial Extent
Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Cary is accustomed to smaller scale severe winter weather conditions and often

receives severe winter weather during the winter months. Given the atmospheric nature of the hazard, the entire jurisdiction has uniform exposure to a winter storm.

Historical Occurrences

Severe winter weather has resulted in six disaster declarations in Cary. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. [9] According to the National Climatic Data Center, there have been no recorded winter storm events in Cary since 1993 (**Table B.16**).[10] These events resulted in $0 (2013 dollars) in damages. However, there have been 28 recorded countywide events and most severe winter weather events are only recorded at the county level.

TABLE B.16: SUMMARY OF WINTER STORM EVENTS IN CARY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Cary	0	0/0	$0

Source: National Climatic Data Center

There have been several severe winter weather events to impact Cary. The text below describes one of the major events and associated impacts on the county. Similar impacted can be expected with severe winter weather.

1996 Winter Storm

This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and power outages. Furthermore, citizens may resort to using inappropriate heating devices that could to fire or an accumulation of toxic fumes.

Probability of Future Occurrences

Winter storm events will remain a somewhat regular occurrence in Cary due to location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

B.2.9 Earthquake

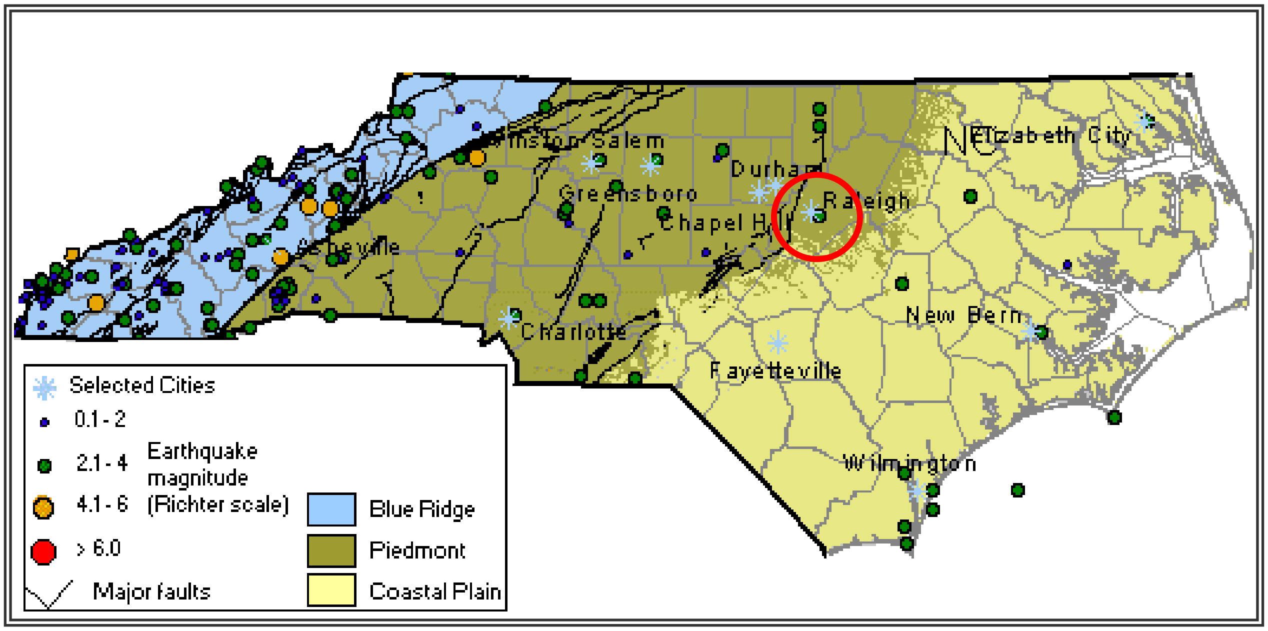
Location and Spatial Extent

Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there

[9] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[10] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional winter storm conditions have affected Cary.

are several smaller fault lines throughout North Carolina. **Figure B.2** is a map showing geological and seismic information for North Carolina.

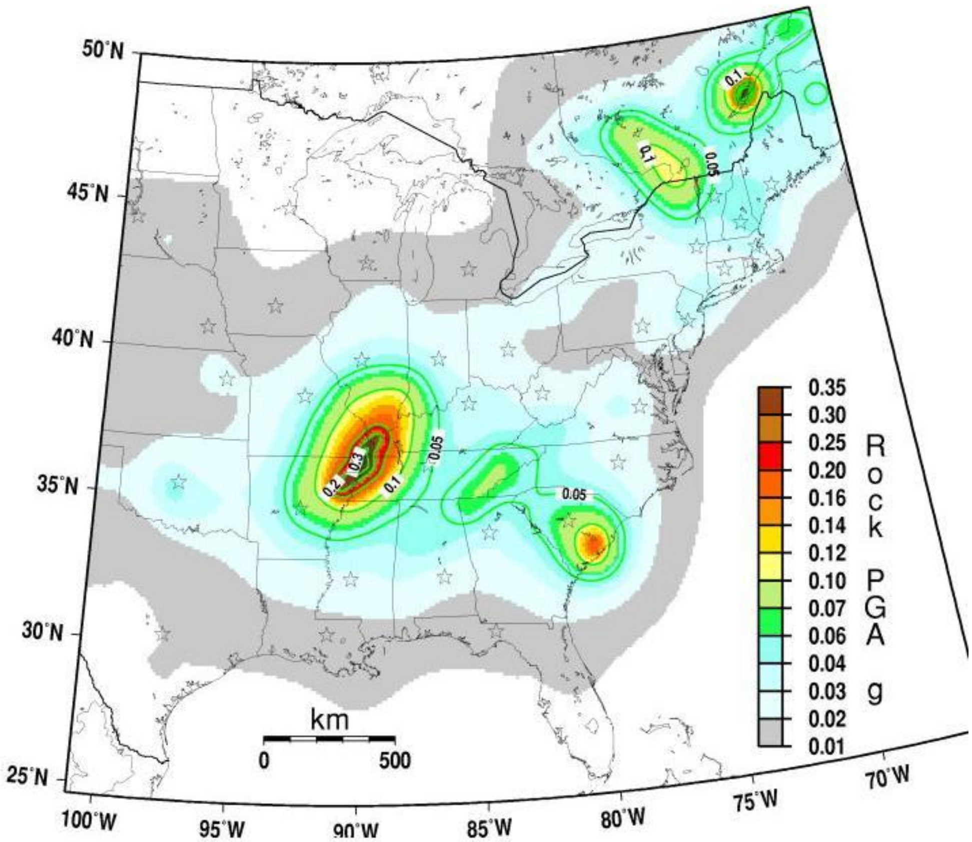
FIGURE B.2: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure B.3 shows the intensity level associated with Cary, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Cary lies within an approximate zone of level "2" to "3" ground acceleration. This indicates that the county exists within an area of moderate seismic risk.

FIGURE B.3: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

Historical Occurrences

Although no earthquakes are known to have occurred directly in Cary since 1874, several have occurred in the county and affected the municipality. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table B.17** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table B.18** presents a detailed occurrence of each event including the date, distance for the epicenter, and Modified Mercalli Intensity (if known).[11]

TABLE B.17: SUMMARY OF SEISMIC ACTIVITY IN CARY

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Cary	--	--	--

Source: National Geophysical Data Center

[11] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

TABLE B.18: SIGNIFICANT SEISMIC EVENTS IN CARY (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI (magnitude)
Cary				
None reported				

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Cary, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table B.19.**

TABLE B.19: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 - 1	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928*	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957*	Buncombe County, NC	3.7	VI	VI
11/24/1957*	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973*	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Cary occurrences.
** Conflicting reports on this event, intensity in North Carolina could have been either V or VI
Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Cary is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. The annual probability level for the county is estimated between 1 and 10 percent (possible).

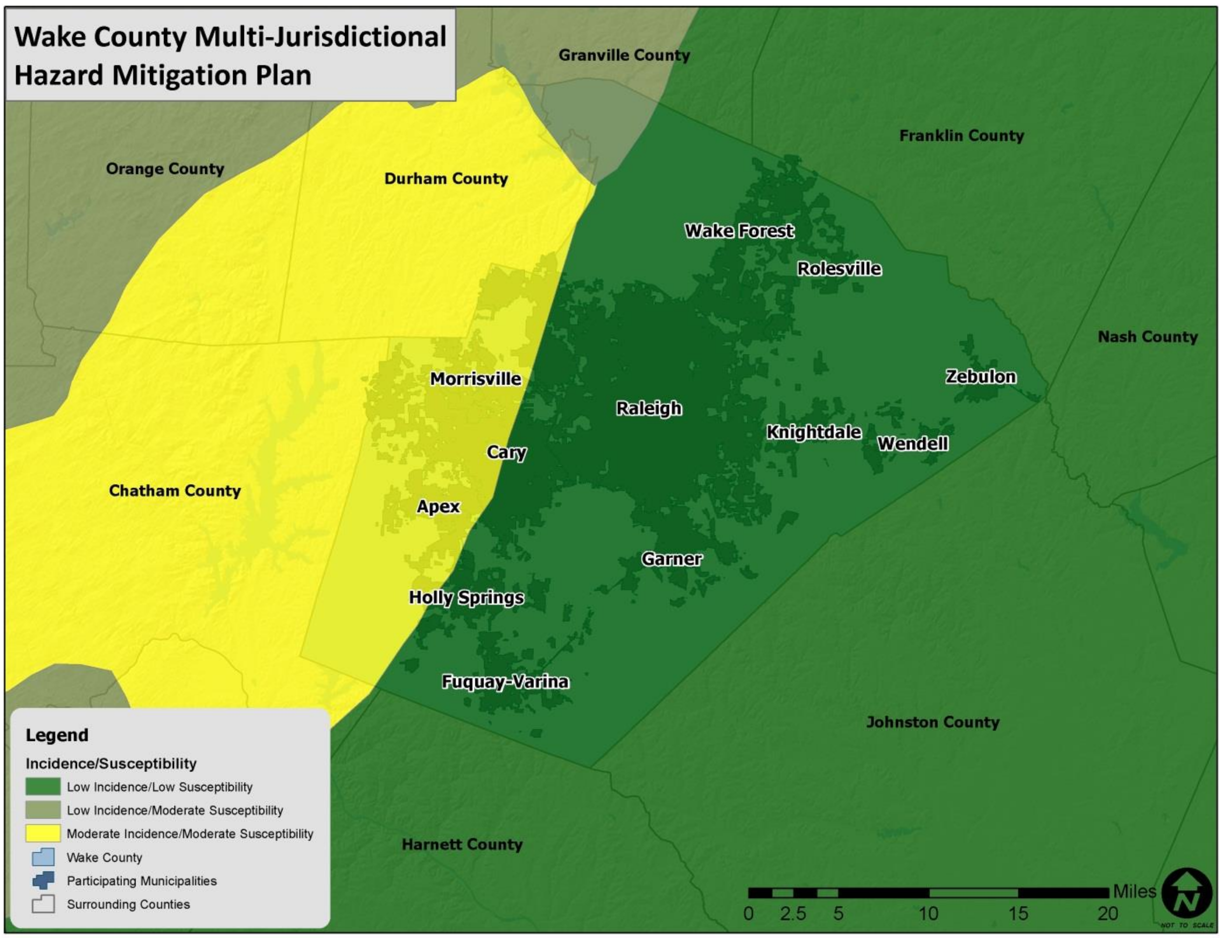
B.2.10 Landslide

Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Cary, although the overall risk is relatively low.

According to **Figure B.4** below, the majority of the county has low landslide activity. However there is a small area along the western border of the county (which includes parts of Cary) that has a moderate incidence and moderate susceptibility. In all other areas, there is low susceptibility.

FIGURE B.4: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

Historical Occurrences

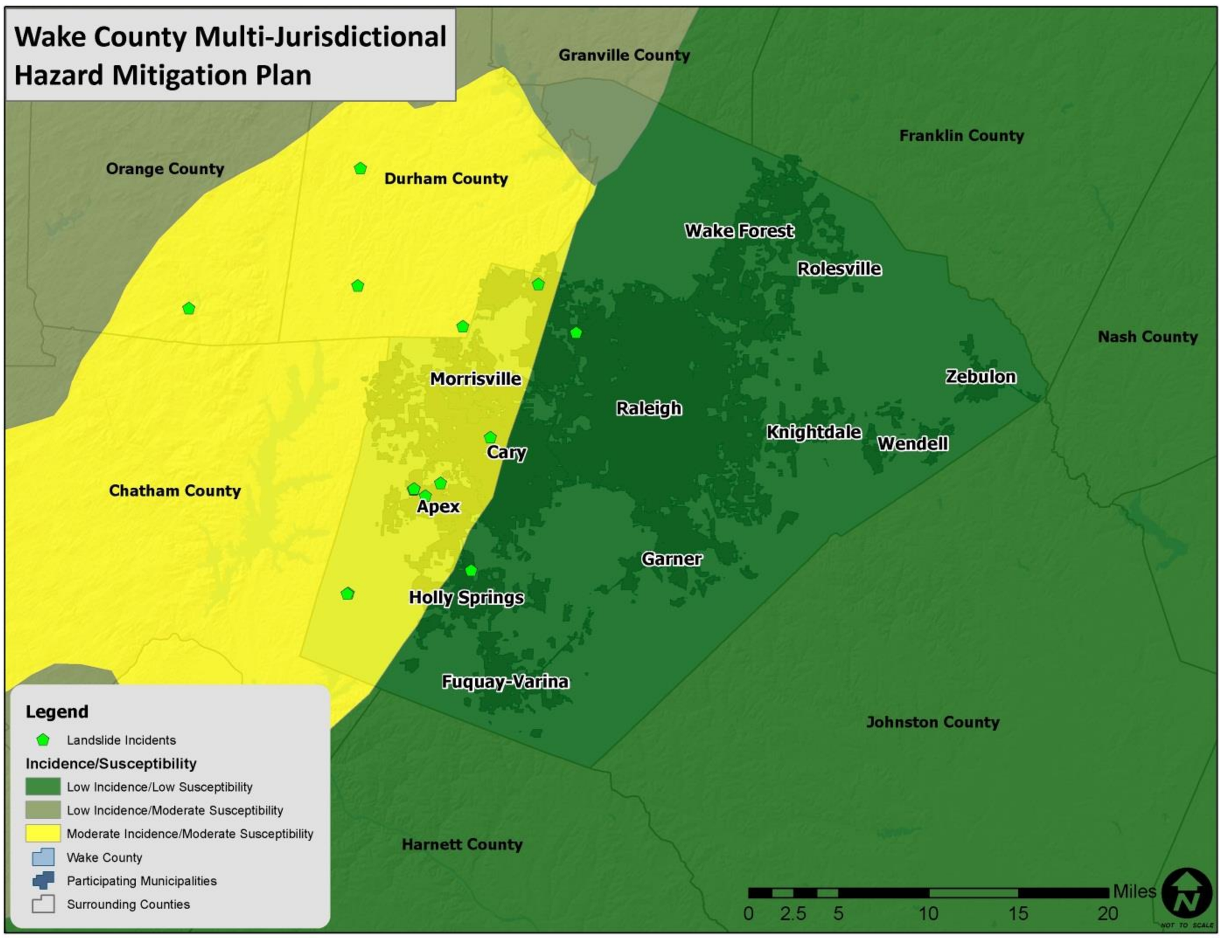
Steeper topography in some areas of Cary make the planning area susceptible to landslides. Most landslides are caused by heavy rainfall in the area. Building on steep slopes that was not previously possible also contributes to risk. **Table B.20** presents a summary of the landslide occurrence events as provided by the North Carolina Geological Survey[12]. The georeferenced locations of the landslide events presented in the aforementioned tables are presented in **Figure B.5**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred in Cary.

TABLE B.20: SUMMARY OF LANDSLIDE ACTIVITY IN CARY

Location	Number of Occurrences
Cary	1

Source: North Carolina Geological Survey

FIGURE B.5: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for

[12] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Cary have greater risk than others given factors such as steepness on slope and modification of slopes.

B.2.11 Dam and Levee Failure

Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table B.21** explains these classifications.

TABLE B.21: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

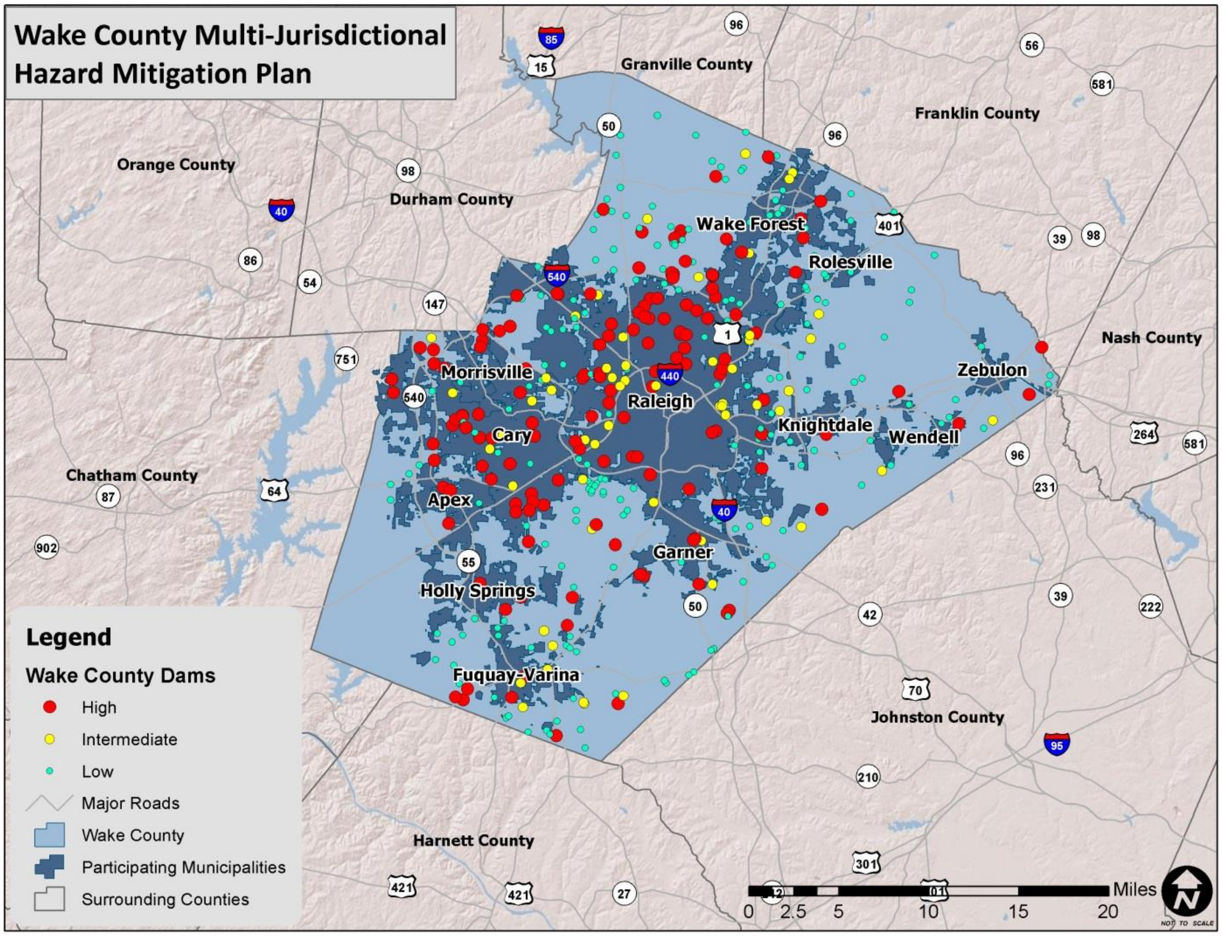
Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

According to the North Carolina Division of Land Management there are 36 dams in Cary.[13] **Figure B.6** shows the dam location and the corresponding hazard ranking for each. Of these dams, 23 are classified as high hazard potential. These high hazard dams are listed in **Table B.22**.

[13] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE B.6: WAKE COUNTY DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE B.22: CARY HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Cary				
Fred G Bond Dam	High	80	666	Local Gov
Tryon Road Dam	High	0	0	Local Gov
Jack Rigsbee Dam	High	2	20	Private
Preston Crossings Dam	High	2	18.8	Private
Rigsbee Dam	High	3	24	Private
Barbee Dam	High	1.9	12	Private
Blackhawk Dam	High	3.2	26	Private
Adams Dam	High	2	17	Private
Coronado Lake Dam	High	4.4	26	Private
Hobby Dam	High	2	16	Private
Regency Park Dam	High	27.3	350	Private
Kildaire Farms Dam	High	30	420	Private
Lochmere Dam	High	70	728	Private

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Audubon Parc Dam	High	0.9	8.1	Private
Lake Amberly Dam	High	14.1	0	Private
Searstone	High	1.3	9	Private
Panther Creek Dam	High	24	202	
Lochmere Lake Dam #2	High	16.3	196	
Loch Highlands Dam	High	6.4	59	
Lake Crabtree	High	473	8950	
Huggins Glen Dam	High	0	80	
Powell Tract Dam	High	0	9999	
Woolner Dam	High	1	11	

Source: North Carolina Division of Land Resources, 2012

It should also be noted that the North Carolina dam classification regulations were recently updated. As a result of the change, more dams are generally classified as high hazard.

Historical Occurrences

No dam breaches were reported in Cary. However, several breach scenarios in the jurisdiction could cause substantial damage.

Probability of Future Occurrences

Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

B.2.12 Erosion

Location and Spatial Extent

Erosion in Cary is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Cary soils have greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Cary, particularly along the banks of rivers and streams, but it is not an extreme threat. No areas of concern were reported by the planning committee.

Historical Occurrences

Several sources were vetted to identify areas of erosion in Cary. This includes searching local newspapers, interviewing local officials, and reviewing the previous hazard mitigation plan. Little information could be found and erosion was not addressed in the previous Cary hazard mitigation plan.

Probability of Future Occurrences

Erosion remains a natural, dynamic, and continuous process for Cary, and it will continue to occur. The annual probability level assigned for erosion is possible (between 1 and 10 percent annually).

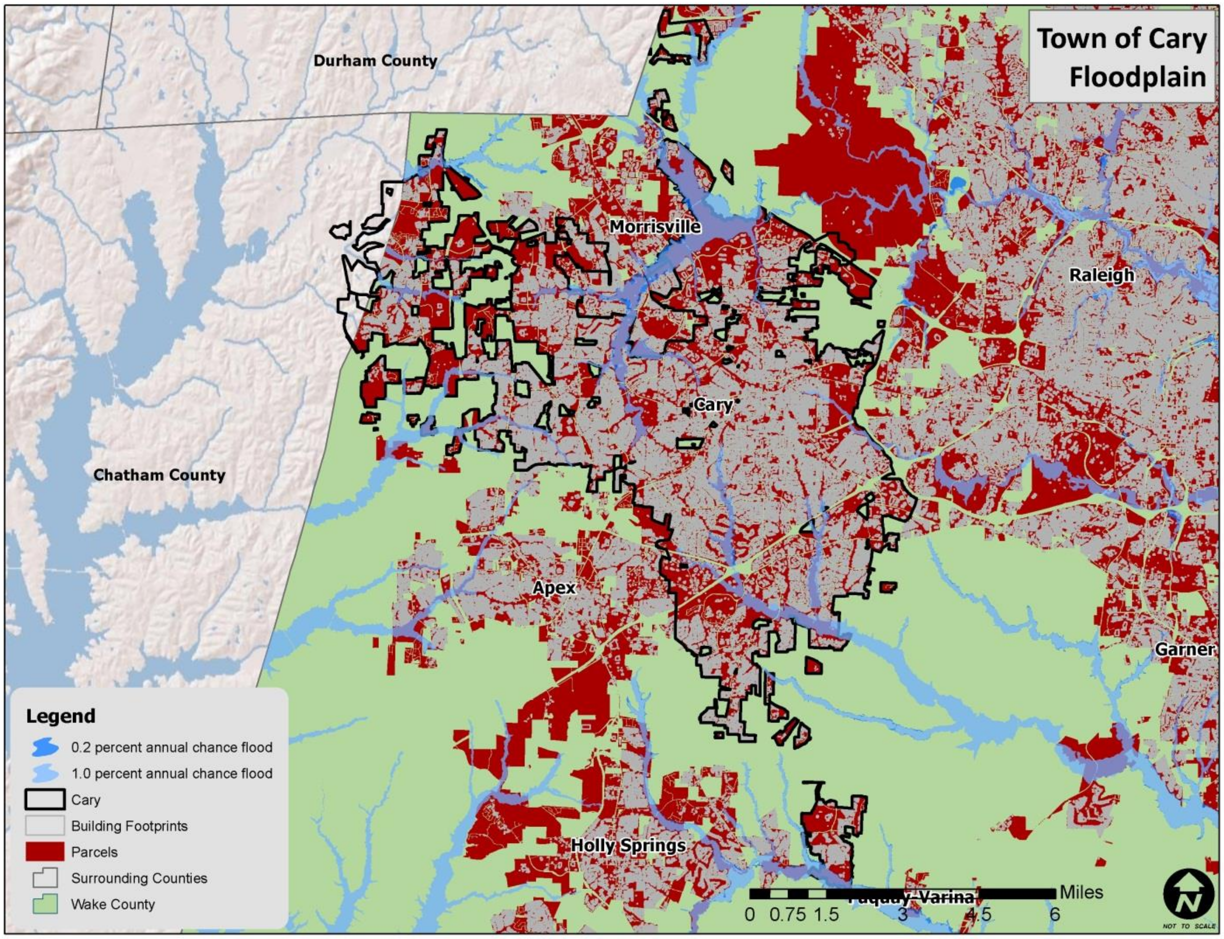
B.2.13 Flood

Location and Spatial Extent

There are areas in Cary that are susceptible to flood events. Special flood hazard areas in the jurisdiction were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[14] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 54 square miles that make up Cary, there are 4.49 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain).

These flood zone values account for 8.3 percent of the total land area in Cary. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas. **Figure B.7** illustrates the location and extent of currently mapped special flood hazard areas for Cary based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.

FIGURE B.7: SPECIAL FLOOD HAZARD AREAS IN CARY



Source: Federal Emergency Management Agency

[14] The county-level DFIRM data used for Cary were updated in 2010.

Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported a total of 4 events in Cary since 1993.[15] A summary of these events is presented in **Table B.23**. These events accounted for over $0 (2013 dollars) in property damage in the county.[16] Specific information on flood events, including date, type of flooding, and deaths and injuries, can be found in **Table B.24**.

TABLE B.23: SUMMARY OF FLOOD OCCURRENCES IN CARY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Cary	4	0/0	$0

Source: National Climatic Data Center

TABLE B.24: HISTORICAL FLOOD EVENTS IN CARY

	Date	Type	Deaths/ Injuries	Property Damage*
Cary				
CARY	6/23/2006	FLASH FLOOD	0/0	$0
CARY	7/17/2007	FLASH FLOOD	0/0	$0
CARY	8/6/2011	FLASH FLOOD	0/0	$0
CARY	7/24/2011	FLASH FLOOD	0/0	$0

Source: National Climatic Data Center

Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there have been 83 flood losses reported in Cary through the National Flood Insurance Program (NFIP) since 1978. A summary of these figures for the jurisdiction is provided in **Table B.25**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that additional instances of flood loss in Cary were either uninsured, denied claims payment, or not reported.

TABLE B.25: SUMMARY OF INSURED FLOOD LOSSES IN CARY

Location	Flood Losses	Claims Payments
Cary	83	$1,297,771

Source: FEMA, NFIP

Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

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[15] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.

[16] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

As of July 2013, there are 13 non-mitigated repetitive loss properties located in Cary, which accounted for 33 losses and $635,412 in claims payments under the NFIP. Without mitigation, repetitive loss properties will likely continue to experience flood losses. **Table B.26** presents detailed information on repetitive loss properties and NFIP claims and policies for Cary.

TABLE B.26: SUMMARY OF REPETITIVE LOSS PROPERTIES IN CARY

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Cary	13	13 single family	33	$460,622	$174,791	$635,412	$19,255

Source: National Flood Insurance Program

Probability of Future Occurrences

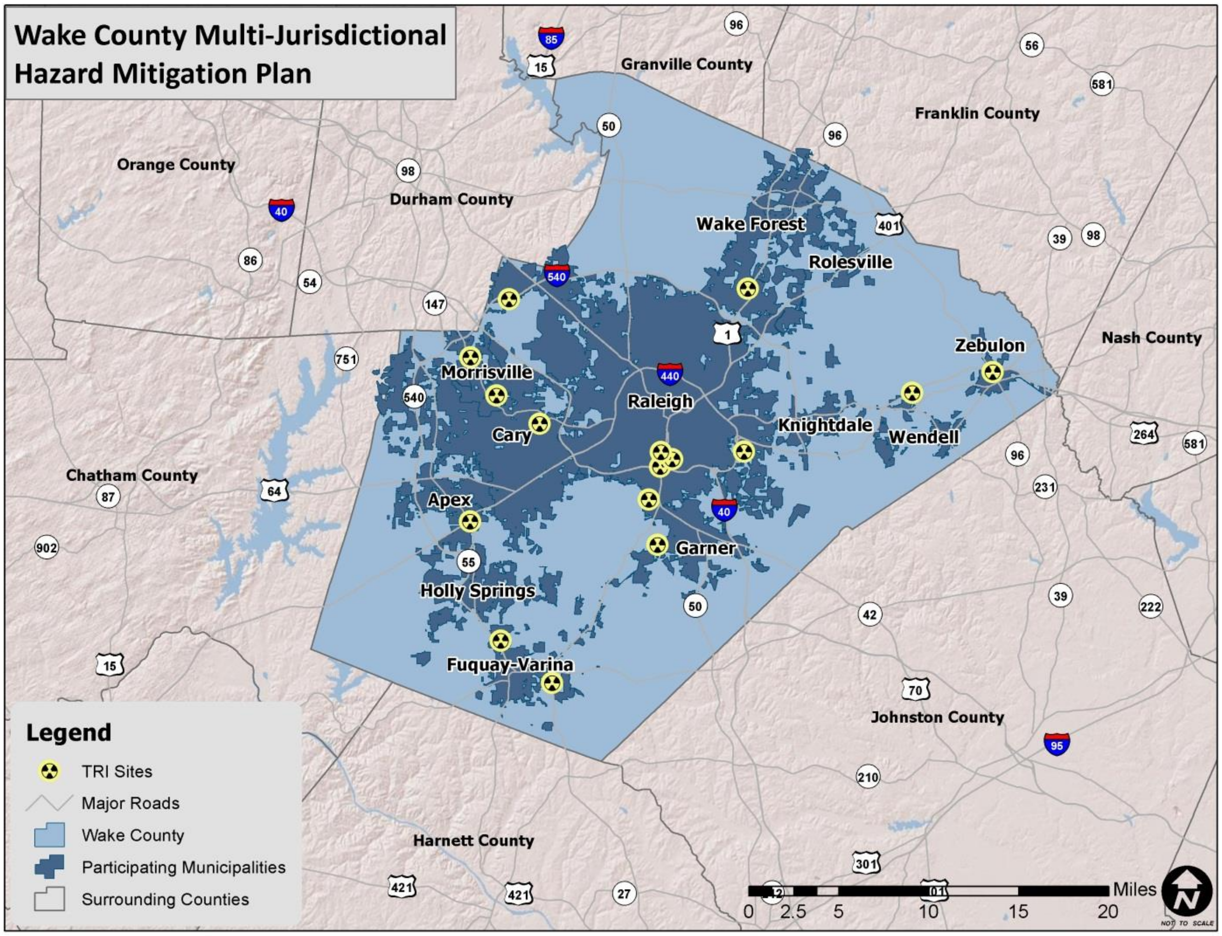
Flood events will remain a threat in areas prone to flooding in Cary, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability) The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above**,** which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

B.2.14 Hazardous Materials Incidents

Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Cary has two TRI sites. This site is shown in **Figure B.8.**

FIGURE B.8: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the jurisdiction via roadways and rail. All roads that permit hazardous material transport are considered potentially at risk to an incident.

Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table B.27 presents detailed information on historic HAZMAT incidents reported in Cary.

TABLE B.27: SUMMARY OF HAZMAT INCIDENTS IN CARY

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Cary							
I-2000060136	5/25/2000	CARY	Highway	No	0/0	$0	20 LGA

Source: USDOT PHMSA

Probability of Future Occurrences

Given the location of two toxic release inventory sites in Cary and several roadways and rails that transport hazardous materials, it is possible that a hazardous material incident may occur in the jurisdiction (between 1 percent and 10 percent annual probability). Local officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

B.2.15 Wildfire

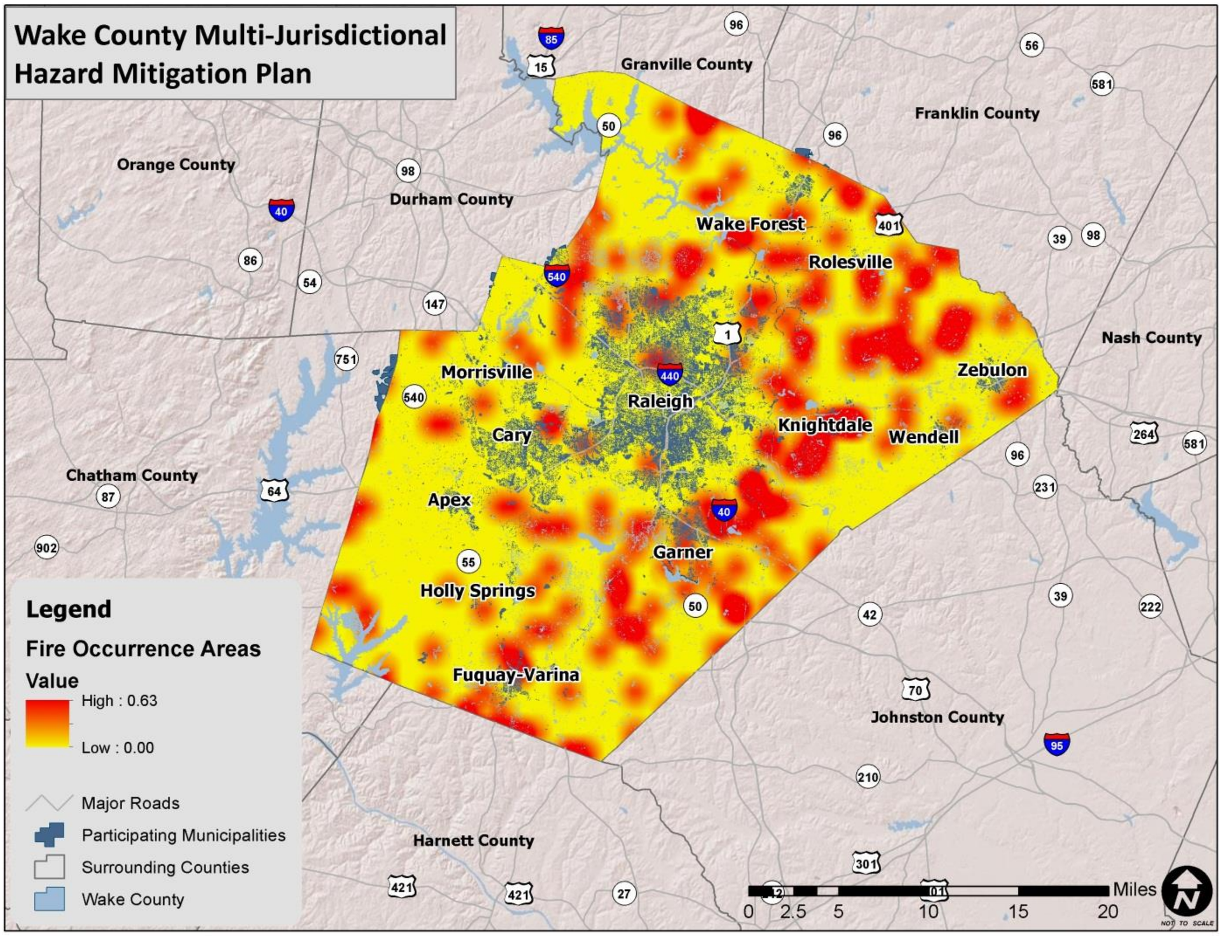
Location and Spatial Extent

The entire jurisdiction is at some risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas.

Historical Occurrences

Figure B.9 shows the Fire Occurrence Areas (FOA) in Cary based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. Therefore, even areas classified as at relatively high risk within the county are a relatively low risk compared to other areas of the state.

FIGURE B.9: HISTORIC WILDFIRE EVENTS IN CARY



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of 16 wildfires annually which burn an average of 98 acres per year. The data indicates that most of these fires are small, averaging six acres per fire. **Table B.28** lists the number of reported wildfire occurrences in the county between the years 2003 and 2012.

TABLE B.28: HISTORICAL WILDFIRE OCCURRENCES IN WAKE COUNTY

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Cary. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Cary for future wildfire events is possible (a 1 and 10 percent annual probability).

B.2.16 Nuclear Accident

Location and Spatial Extent

The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station.

Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 “Alerts” and 28 “Notice of Unusual Events” since 1986, which are shown in **Table B.29**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table B.29: SHEARON HARRIS EMERGENCY DECLARATION HISTORY

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on “B” Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).

Emergency Declaration	Date	Description
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of "A" Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - "B" diesel generator was being worked on; in accordance with test procedures, "A" diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported "Notice of Unusual Events" since 1986, which is shown in **Table B.30**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table B.30: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Probability of Future Occurrences

A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

B.2.17 Terror Threat

Location and Spatial Extent

A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table B.31** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

TABLE B.31 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food	▪ Government Facilities
▪ Banking and Finance	▪ Healthcare and Public Health
▪ Chemical	▪ Information Technology
▪ Commercial Facilities	▪ National Monuments and Icons
▪ Communications	▪ Nuclear Reactors, Materials, and Waste
▪ Critical Manufacturing	▪ Postal and Shipping
▪ Dams	▪ Transportation Systems
▪ Defense Industrial Base	▪ Water
▪ Emergency Services	
▪ Energy	

Historical Occurrences

Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

Probability of Future Occurrences

Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

B.2.18 Conclusions on Hazard Risk

The hazard profiles presented above were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and

experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

Hazard Extent

Table B.32 describes the extent of each natural hazard identified for Cary. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE B.32 EXTENT OF CARY HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page B:4). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Cary has received this ranking three times over the fourteen year reporting period.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Cary was 2.25 inches. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), Cary is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Thunderstorm Wind/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Cary was reported at 60 knots (approximately 69 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). The greatest magnitude reported was an F0 (reported in 1996 and 2001).
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Cary. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is between low and moderate in Cary. There is also moderate susceptibility in some areas.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). Of the 36 dams in Cary, 23 are classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records located in Cary.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 8.3 percent of the total land area in Cary. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second.
Other Hazards	
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incident reported in Cary is 20 LGA released on the highway in Cary. It should be noted that larger events are possible.
Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).

Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

Priority Risk Index Results

In order to draw some meaningful planning conclusions on hazard risk for Cary, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). More information on the PRI and how it was calculated can be found in Section 5.20.2.

Table B.33 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups and Coordinating Committee. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE B.33: SUMMARY OF PRI RESULTS FOR CARY

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	2.5
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	2.4
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	2.5
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	2.9
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	2.1
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	3.1
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	2.7
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	2.5
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	2
Landslide	Possible	Minor	Small	Less than 6 hours	Less than 6 hours	1.8
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	2.1
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	1.8
Flood	Likely	Critical	Moderate	6 to 12 hours	Less than 1 week	3
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	2.5
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	2
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	2.6
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	2.4

B.2.16 Final Determinations on Hazard Risk

The conclusions drawn from the hazard profiling process for Cary, including the PRI results and input from the Regional Work Groups and Coordinating Committee, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table B.34**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Cary. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment* and below in Section B.3. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE B.34: CONCLUSIONS ON HAZARD RISK FOR CARY

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Nuclear Accident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

B.3 TOWN OF CARY VULNERABILITY ASSESSMENT

This subsection identifies and quantifies the vulnerability of Cary to the significant hazards previously identified. This includes identifying and characterizing an inventory of assets in the county and assessing the potential impact and expected amount of damages caused to these assets by each identified hazard event. More information on the methodology and data sources used to conduct this assessment can be found in Section 6: *Vulnerability Assessment*.

B.3.1 Asset Inventory

Table B.35 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for Cary (study area of vulnerability assessment).[17]

TABLE B.35: IMPROVED PROPERTY IN CARY

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Cary	46,916	$19,442,602,988	41,362	$14,004,724,996

Table B.36 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in Cary. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. In addition, a list of secondary facilities was created to recognize the importance of these facilities in the event of a disaster. These facilities were not mapped, but it is important to recognize that they could be potentially impacted by nearly any of the identified hazards, especially those that are atmospheric or have no specific spatial delineation.

All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure B.10** shows the locations of the primary critical facilities in Wake County. **Table B.48**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility. As noted previously, this list is not all-inclusive and only includes information provided by the local government.

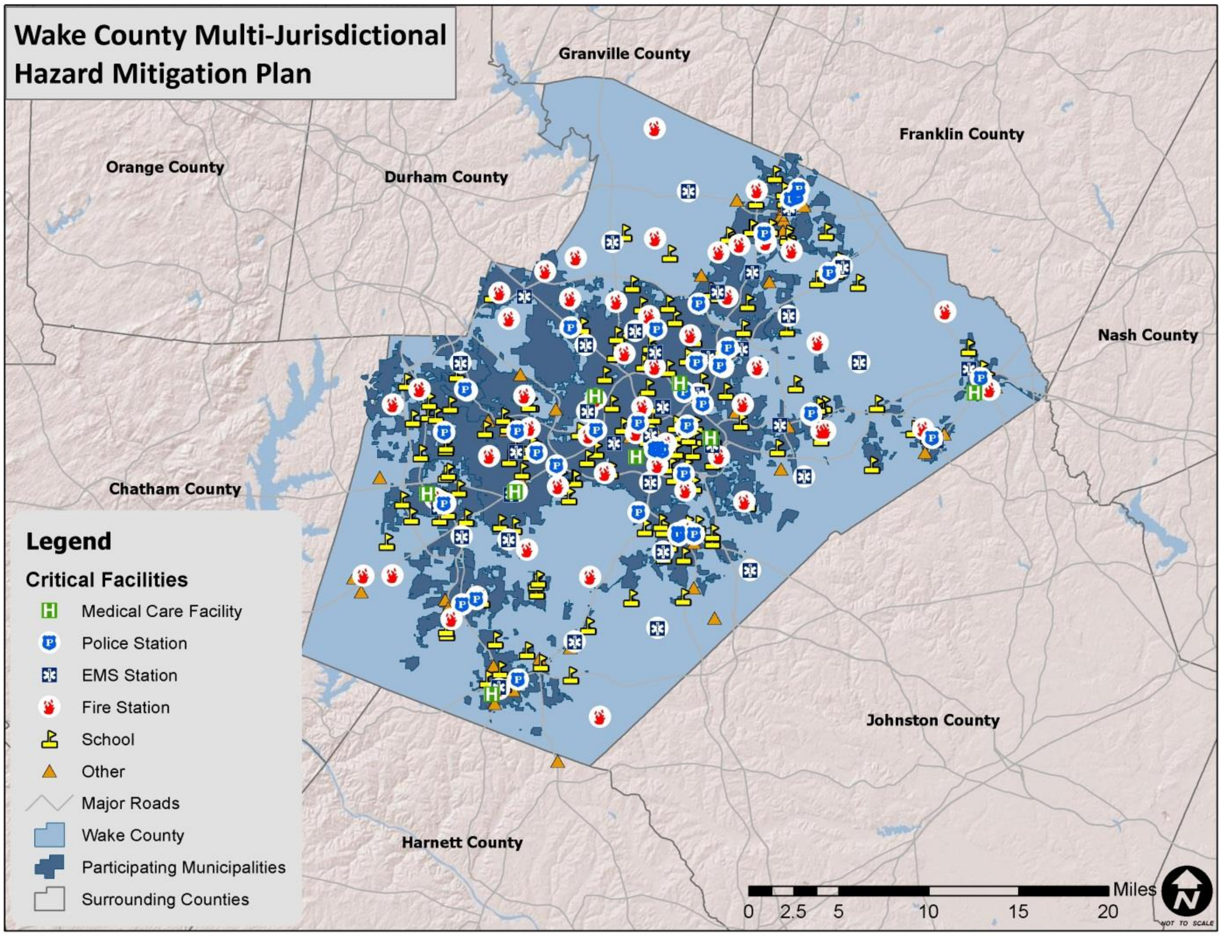
TABLE B.36: CRITICAL FACILITY INVENTORY IN CARY

Location	Fire Stations	Police Stations	EMS Stations	Medical Care Facilities	Schools	Other
Cary	10	4	4	1	26	5

Source: Local Governments

[17] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

FIGURE B.10: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: Local Governments

B.3.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Cary that are potentially at risk to these hazards.

Table B.37 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, limited the results to county-wide estimates. The total population in Cary according to Census data is 135,234 persons. Additional population estimates are presented above in Section B.1.

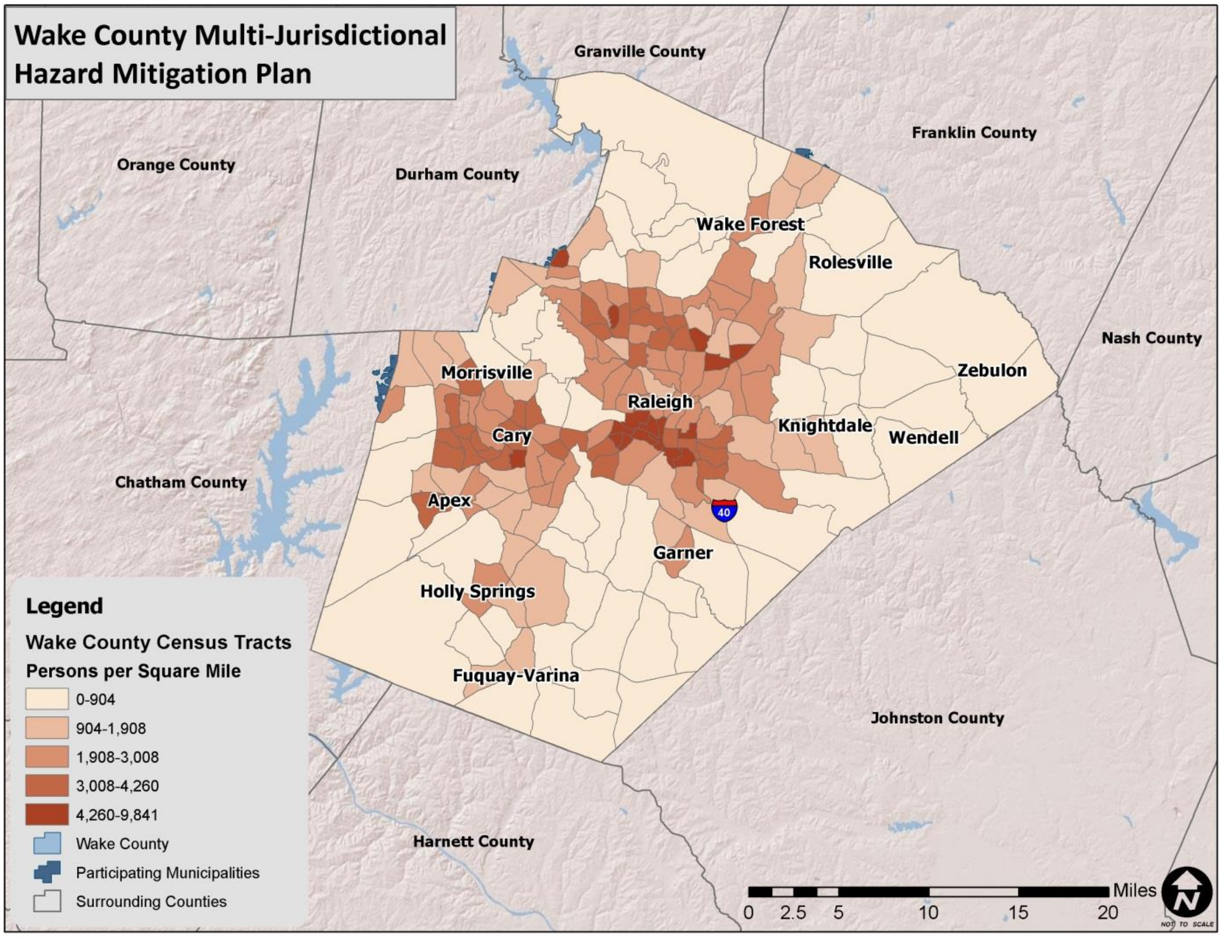
TABLE B.37: TOTAL POPULATION IN CARY

Location	Total 2010 Population
Cary	135,234

Source: U.S. Census 2010

In addition, **Figure B.11** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[18]

FIGURE B.11: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

B.3.3 Vulnerability Assessment Results

As noted in Section 6: *Vulnerability Assessment*, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results, specific to Cary, are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total county exposure, and thus risk, was presented in **Table B.35.**

The annualized loss estimate for all hazards is presented at the end of this section in **Table B.47.**

The hazards presented in this section include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

[18] Population by census block was not available at the time this plan was completed.

Hurricane and Tropical Storm

Historical evidence indicates that Cary has a significant risk to the hurricane and tropical storm hazard. Several tracks have come near or traversed through the county, as shown and discussed in Section B.2.4.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes, and high winds and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table B.38.** Only losses to buildings are reported, in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE B.38: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table B.39.**

TABLE B.39: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Cary	74.2	83.4	102.3	109.0

Source: Hazus-MH 2.1

Social Vulnerability

Given equal susceptibility across the county, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Cary, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table B.48** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Cary. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

Earthquake

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table B.40** summarizes the findings.

TABLE B.40: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability

It can be assumed that all existing future populations are at risk to the earthquake hazard.

Critical Facilities

The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table B.48**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Cary. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

Landslide

In order to complete the vulnerability assessment for landslides in Cary, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section B.2.10), tax parcel and building footprint data, and GIS analysis. **Table B.41** presents the potential at-risk property where available. All areas of Cary are identified as low or moderate incidence areas by the USGS landslide data. Some areas are also of moderate landslide susceptibility. Since there were no high incidence levels in the county, the moderate incidence level was used to identify different areas of concern for the analysis below.

TABLE B. 41: TOTAL POTENTIAL AT-RISK PARCELS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	**Moderate**		
Cary	30,128	24,023	$8,633,636,293

Source: USGS

Social Vulnerability
Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides. However, Cary is probably at somewhat higher risk than other jurisdictions.

Critical Facilities
All critical facilities are located in a moderate susceptibility area. This includes 1 EMS station, 3 fire stations, 1 medical care facility, 1 police station, 11 schools, and 4 others. A list of specific critical facilities and their associated risk can be found in **Table B.48** at the end of this section.

In conclusion, a landslide has the potential to impact existing and future buildings, facilities, and populations in Cary, though some areas are at a higher risk than others due to a variety of factors. For example, steep slopes and modified slopes bear a greater risk than flat areas. Specific vulnerabilities for county assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

Flood
Historical evidence indicates that Cary is susceptible to flood events. A total of 4 flood events have been reported by the National Climatic Data Center resulting in $0 in damages. On an annualized level, these damages amounted to $0 for Cary.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for the county. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table B.42** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

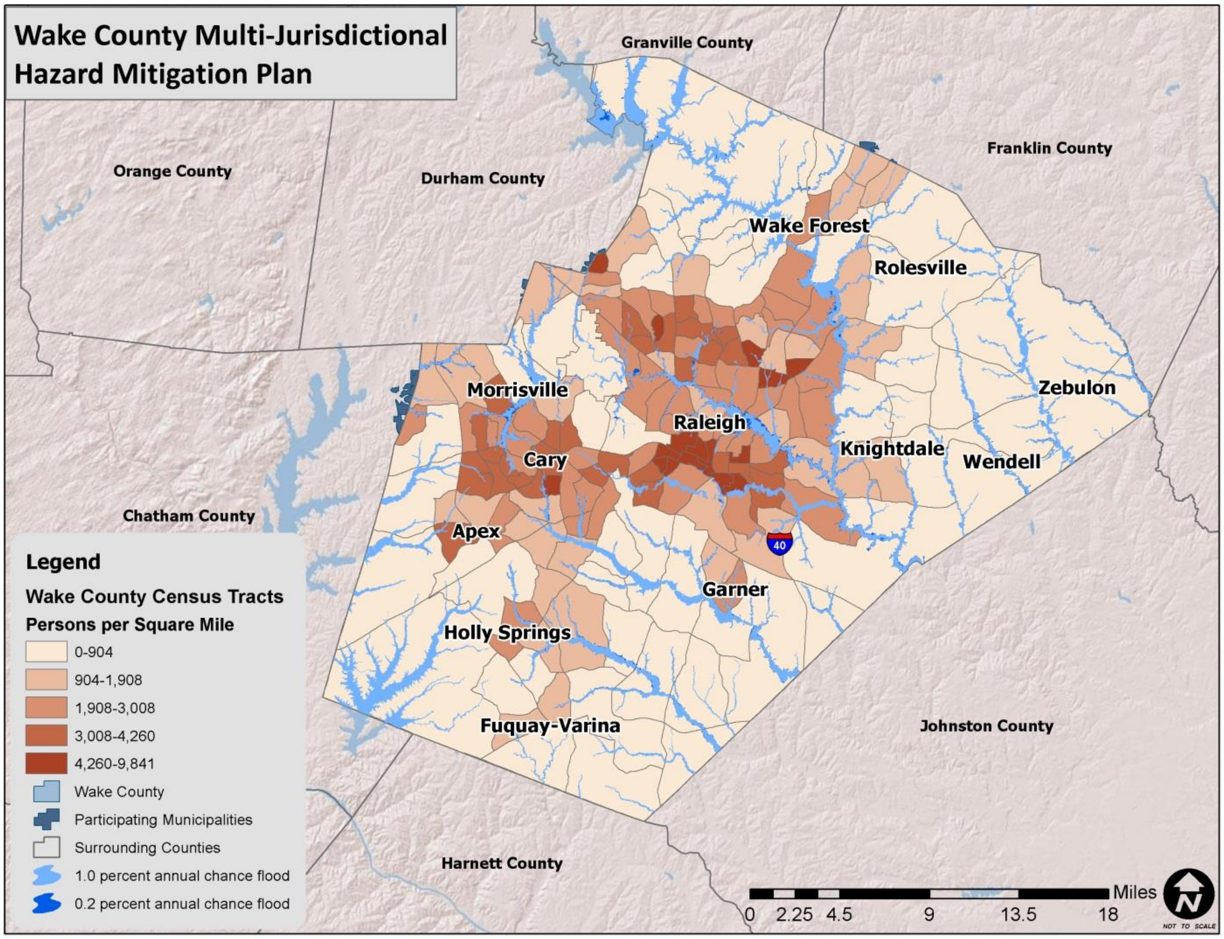
TABLE B.42: ESTIMATED EXPOSURE OF PARCELS TO THE FLOOD HAZARD

Location	1.0-percent ACF			0.2-percent ACF		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings
Cary	1,377	536	$889,772,939	220	126	$114,270,309

Source: FEMA DFIRM

Social Vulnerability
Since 2010 population was available at the tract level, it was difficult to determine a reliable figure on population at-risk to flood due to tract level population data. **Figure B.12** is presented to gain a better understanding of at risk population.

FIGURE B.12 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities

The critical facility analysis revealed that there are a no critical facilities located in the Cary 1.0-percent annual chance floodplain and 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. A list of specific critical facilities and their associated risk can be found in **Table B.48** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings and populations in Cary, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

Hazardous Materials Incident

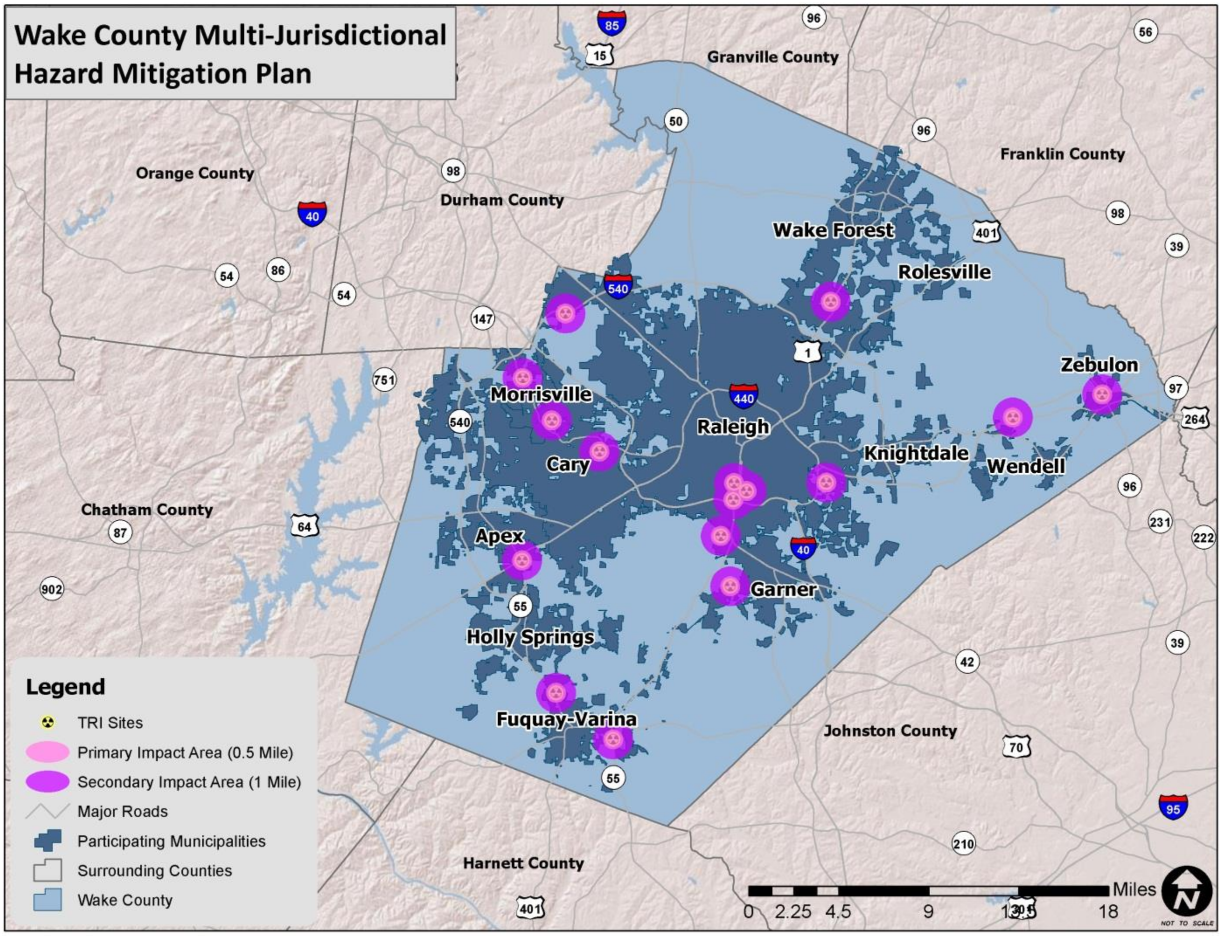
Although historical evidence and existing Toxic Release Inventory sites indicate that Cary is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Cary.

Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[19] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Cary, along with buffers, were used for analysis as shown in **Figure B.13.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the GIS buffer analysis. **Figure B.14** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table B.43** (fixed sites), **Table B.44** (mobile road sites) and **Table B.45** (mobile railroad sites).[20]

[19] This type of analysis will likely yield inflated results (generally higher than what is actually reported after an event).
[20] Note that parcels included in the 1.0-mile analysis are also included in the 0.5-mile analysis.

FIGURE B.13 : TRI SITES WITH BUFFERS IN CARY



Source: EPA

TABLE B.43: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Cary	955	1,256	$286,638,537	4,017	4,547	$1,052,794,000

FIGURE B.14 : MOBILE HAZMAT BUFFERS IN CARY

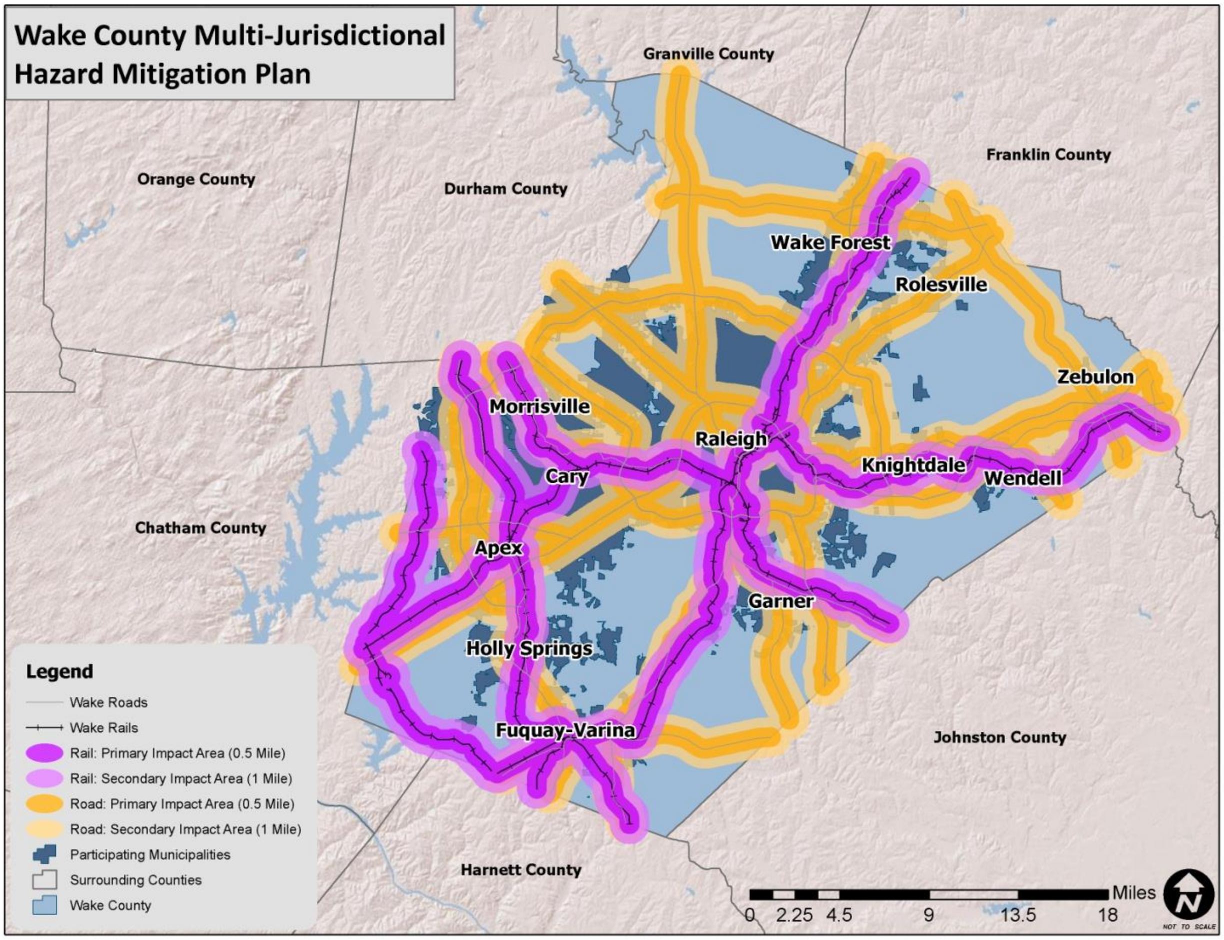


TABLE B.44: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Cary	12,009	10,601	$4,743,131,291	26,072	22,519	$8,772,490,046

TABLE B.45: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Cary	12,115	11,396	$2,910,061,363	26,174	23,339	$6,618,704,404

Social Vulnerability

Given high susceptibility across the jurisdiction, it is assumed that the total population is at risk to a hazardous materials incident. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities

Fixed Site Analysis:

The critical facility analysis for fixed TRI sites revealed that 3 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes just 1 facility, a fire station. The remaining facilities are in the secondary, 1.0-mile zone. A list of specific critical facilities and their associated risk can be found in **Table B.48** at the end of this section.

Mobile Analysis:

The critical facility analysis for road and railroad transportation corridors in Cary revealed that there are 30 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 17 facilities. The remaining facilities are in the secondary, 1.0-mile zone. The railroad buffer areas include 25 facilities with 19 in the primary impact zone. It should be noted that many of the facilities located in the buffer areas for railroad are also located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table B.48** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Cary. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc. Further, incidents from neighboring jurisdictions could also have an impact.

Wildfire

Although historical evidence indicates that Cary is susceptible to wildfire events, there are few reports of damage. Upon conversion of the wildfire risk data (see Section 6: *Vulnerability Assessment*) and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the jurisdiction should be assumed to be very low. As such, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the county.

Social Vulnerability

All areas have relatively equal vulnerability and there is low susceptibility across the entire county.
It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in wildfire areas of concern. It should be noted, however, that several factors could impact the spread of a wildfire putting all facilities at risk. A list of specific critical facilities and their associated risk can be found in **Table B.48** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Cary.

Nuclear Accident

The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table B.46** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE B.46: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[21]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[22]
Cary	782	766	$285,094,552	46,916	41,362	$14,004,724,996

Social Vulnerability

Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities

The critical facility analysis revealed that there is one critical facility located in the 10-mile nuclear buffer area, a water reclamation facility.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in Cary, though areas closer to the power plant are at a higher risk than others. All structures are at some risk given that they are all located within at least the 50-mile buffer area.

Conclusions on Hazard Vulnerability

Table B.47 presents a summary of annualized loss for each hazard in Cary. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, although an annualized loss was determined through the damage reported through historical occurrences at the municipal level, it is likely that the county-wide

[21] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.
[22] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

estimate (found in Section 6: *Vulnerability Assessment*) is potentially a better estimate. These values should be used as an additional planning tool or measure risk for determining hazard mitigation strategies.

TABLE B.47: ANNUALIZED LOSS FOR CARY*

Event	Cary
Dam Failure	Negligible
Drought	Negligible
Erosion	Negligible
Extreme Heat	Negligible
Hail	$450
Hurricane & Tropical Storm	Negligible
Landslide	Negligible
Lightning	$8,879
Thunderstorm Wind/High Wind[23]	$2,560
Tornado	$4,875
Winter Storm & Freeze	Negligible
Flood	Negligible
Earthquake	Negligible
HAZMAT Incident	Negligible
Wildfire	Negligible
Nuclear Accident	Negligible
Terror Threat	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table B.48** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

[23] The annualized losses for these hazards were combined.

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TABLE B.48: AT-RISK CRITICAL FACILITIES IN CARY

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER								
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
CARY																								
CARY MAIN	EMS STATION	X	X	X	X	X	X	X	X	X													X	X
FAIRVIEW	EMS STATION	X	X	X	X	X	X	X	X	X													X	X
CARY WEST	EMS STATION	X	X	X	X	X	X	X	X	X		X							X	X			X	X
CARY SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
MORRISVILLE #3	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
CARY #4	FIRE STATION	X	X	X	X	X	X	X	X	X		X							X	X			X	X
CARY #5	FIRE STATION	X	X	X	X	X	X	X	X	X		X							X	X			X	X
CARY #2	FIRE STATION	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X			X	X
CARY #1	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
SWIFT CREEK	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
CARY #3	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
CARY #6	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
CARY #7	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
CARY #8	FIRE STATION	X	X	X	X	X	X	X	X	X		X						X					X	X
WESTERN WAKE- WAKEMED	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X							X	X					X	X
WESTERN WAKE REGIONAL WATER RECLAMATION FACILITY	OTHER	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
SOUTH CARY WATER RECLAMATION FACILITY	OTHER	X	X	X	X	X	X	X	X	X													X	X
NORTH CARY WATER RECLAMATION FACILITY	OTHER	X	X	X	X	X	X	X	X	X		X					X	X					X	X
SOLID WASTE TRANSFER STATION	OTHER	X	X	X	X	X	X	X	X	X		X						X	X	X			X	X
PUBLIC WORKS OPERATIONS CENTER	OTHER	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
CROSSROAD SUBSTATIONS	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
CARY TOWNE CENTER SUBSTATION	POLICE STATION	X	X	X	X	X	X	X	X	X								X					X	X
CARY (MAIN)	POLICE STATION	X	X	X	X	X	X	X	X	X						X		X	X	X			X	X
SUBSTATION	POLICE STATION	X	X	X	X	X	X	X	X	X		X							X	X			X	X
BRIARCLIFF ES	SCHOOL	X	X	X	X	X	X	X	X	X										X			X	X
FARMINGTON WOODS ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
CARY HS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
ADAMS ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
KINGSWOOD ES	SCHOOL	X	X	X	X	X	X	X	X	X						X		X	X	X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
NORTHWOODS ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
WEST LAKE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
GREEN HOPE HS	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
OAK GROVE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
EAST CARY MS	SCHOOL	X	X	X	X	X	X	X	X	X								X		X			X	X
WEST CARY MS	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X		X			X	X
GREEN HOPE ES	SCHOOL	X	X	X	X	X	X	X	X	X		X						X	X	X			X	X
MIDDLE CREEK HS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
TURNER CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X					X	X
HIGHCROFT DRIVE ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X		X			X	X
DAVIS DRIVE MS	SCHOOL	X	X	X	X	X	X	X	X	X		X							X	X			X	X
DAVIS DRIVE ES	SCHOOL	X	X	X	X	X	X	X	X	X		X							X	X			X	X
PANTHER CREEK HS	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X		X			X	X
CARY ES	SCHOOL	X	X	X	X	X	X	X	X	X									X	X			X	X
WEATHERSTONE ES	SCHOOL	X	X	X	X	X	X	X	X	X		X						X		X			X	X
CARPENTER ES	SCHOOL	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
REEDY CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
REEDY CREEK MS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
HARRIET B WEBSTER AT CROSSROADS II ADM	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
MIDDLE CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
PENNY ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X

Secondary Critical Facilities are listed in slight contrast to Critical Facilities as their continued function has not been deemed as critical as primary facilities in the event of a disaster, but these facilities are extremely important. A loss of function to one of these facilities would have a definitively greater negative impact on the community's ability to respond to and recover from a disaster than a loss of function at other facilities/structures within the jurisdiction. In **Table B.49**, these facilities have been classified as either Significant Community Locations/Sheltering Centers or as Critical Resources Management Facilities. These facilities are all vulnerable to any of the atmospheric hazards and many are also likely vulnerable to other hazards identified above, though no locational analysis was carried out to this end.

TABLE B.49: CARY SECONDARY CRITICAL FACILITIES

Facility Name	Address*	Type
Cary		
Pump Stations	• West Cary: 3905 Green Level West Road • Morris Branch: 251 Beckingham Loop • Kit Creek: 2605 Green Level Church Road • Beaver Creek: 2916 Olive Chapel Road • Cary/Cary raw Water: 6750 US 64W at Jordan Lake	Critical Resources Management (Energy, Water, etc.)
US Post Office		Significant Community Location or Sheltering Center
Progress Energy		Critical Resources Management (Energy, Water, etc.)
Public Service Company of NC		Critical Resources Management (Energy, Water, etc.)
Bell South		Critical Resources Management (Energy, Water, etc.)
Rex Urgent Care	1515 SW Cary Parkway	Significant Community Location or Sheltering Center
Train Station	211 N. Academy Street	Critical Resources Management (Energy, Water, etc.)
Cary Academy		Significant Community Location or Sheltering Center
Kids Club School		Significant Community Location or Sheltering Center
Lucy Daniels Center		Significant Community Location or Sheltering Center
Shining Star Academy		Significant Community Location or Sheltering Center
Cary Christian School		Significant Community Location or Sheltering Center

**Some address information could not be provided or was not applicable to the facility*

B.4 TOWN OF CARY CAPABILITY ASSESSMENT

This subsection discusses the capability of the Town of Cary to implement hazard mitigation activities. More information on the purpose and methodology used to conduct the assessment can be found in Section 7: *Capability Assessment*.

B.4.1 Planning and Regulatory Capability

Table B.50 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the Town of Cary. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE B.50: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning Tool/Regulatory Tool	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan (Parks & Rec/Greenway Plan	Stormwater Management Plan/Ordinance	Natural Resource Protection Plan	Flood Response Plan	Emergency Operations Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	National Flood Insurance Program (NFIP)	NFIP Community Rating System
Cary	✓	✓		✓	✓			✓	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	

A more detailed discussion on the county's planning and regulatory capabilities follows.

Emergency Management

Hazard Mitigation Plan
The Town of Cary has previously adopted a hazard mitigation plan.

Emergency Operations Plan
The Town of Cary has adopted the Wake County Emergency Operations Plan. The town also maintains a municipal-level emergency operations plan.

Continuity of Operations Plan
The Town of Cary has adopted a municipal-level continuity of operations plan.

General Planning

Comprehensive Land Use Plan
The Town of Cary has adopted a land use plan as well as a growth management plan.

Capital Improvements Plan
The Town of Cary prepares a 10-year long-range capital improvements plan each year.

Historic Preservation Plan
The Town of Cary has adopted a historic preservation master plan.

Zoning Ordinance
The Town of Cary includes zoning regulations as part of the local unified development ordinance.

Subdivision Ordinance
The Town of Cary also includes subdivision regulations as part of the local unified development ordinance.

Building Codes, Permitting, and Inspections
North Carolina has a state compulsory building code which applies throughout the state. The building code is enforced within the town's planning jurisdiction by the Town of Cary Inspections and Permits Department.

Floodplain Management

Table B.51 provides NFIP policy and claim information for the Town of Cary.

TABLE B.51: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
Cary	07/17/78	04/16/07	729	$211,433,100	83	$1,297,771

Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Flood Damage Prevention Ordinance
All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. The Town of Cary participates in the NFIP and has adopted flood damage prevention regulations.

Open Space Management Plan
The Town of Cary has adopted an open space plan as well as a parks, recreation, and cultural resources facilities master plan.

Stormwater Management Plan
The Town of Cary has adopted a stormwater master plan and also includes stormwater management regulations as part of the local unified development ordinance.

B.4.2 Administrative and Technical Capability

Table B.52 provides a summary of the capability assessment results for the Town of Cary with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in the town with the specified knowledge or skill.

TABLE B.52: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	Planners with knowledge of land development/land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency Manager	Floodplain Manager	Land Surveyors	Scientists familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Resource development staff or grant writers
Cary	✓	✓	✓	✓	✓		✓	✓	✓	

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

B.4.3 Fiscal Capability

Table B.53 provides a summary of the results for the Town of Cary with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plan.

TABLE B.53: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes (or taxing districts)	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.
Cary	✓	✓	✓					✓	✓	✓

B.4.4 Political Capability

The previous hazard mitigation plan indicates that the elected officials of the Town of Cary support the implementation of the hazard mitigation plan as a necessary step to minimize damages from natural hazards and to reduce future loss of life and property. Examples of this commitment are found throughout the adopted Land Development Ordinance, Land Use Plan, Growth Management Plan, Parks, Greenways and Bikeways Master Plan, and Open Space and Historic Resources Plan. The citizens, property owners, business owners, as well as elected officials of the Town of Cary can be counted on to realize the need and enforcement of the hazard mitigation plan. The Town Council continually strives to make the Town of Cary a safer community and see the hazard mitigation plan as means to achieve that goal.

B.4.5 Conclusions on Local Capability

Table B.54 shows the results of the capability assessment using the designed scoring methodology described in Section 7: *Capability Assessment*. The capability score is based solely on the information found in existing hazard mitigation plan and readily available on the town's government website. According to the assessment, the local capability score for the town is 45, which falls into the high capability ranking.

TABLE B.54: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
Cary	45	High

B.5 TOWN OF CARY MITIGATION STRATEGY

This subsection provides the blueprint for Cary to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Regional Work Groups and the findings and conclusions of the capability assessment and risk assessment. Additional Information can be found in Section 8: *Mitigation Strategy* and Section 9: *Mitigation Action Plan*.

B.5.1 Mitigation Goals

Cary developed seven mitigation goals in coordination with Wake County and the other participating municipalities. The county-wide mitigation goals are presented in **Table B.55**.

TABLE B.55: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

B.5.2 Mitigation Action Plan

The mitigation actions proposed by Cary are listed in the following Mitigation Action Plan.

Town of Cary Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Town stormwater staff will continue to maintain current level of control of development in flood hazard areas with ordinance amendments as necessary.	Flood	High	Cary Water Resources	Local	Completed	Amend LDO as needed to maintain or exceed mandated requirements. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-2	Town will continue to participate in the NFIP thereby keeping current with all applicable NFIP flood hazard regulations.	Flood	High	Cary Water Resources	Local	Completed	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-3	Town's Comprehensive Plan- The Town has an existing comprehensive plan which includes land use, parks and recreation, open space, transportation, utilities, and environment.	All	High	Cary Planning	Local	Completed 1996 Regular updates on-going	Town Is in process of preparing new Community Plan incorporating all elements of existing Comp Plan. Adoption expected in 2015.
P-4	Land Use Plan An existing tool which guides future development based on available services and existing site features/resources to ensure that future development is meeting the overall vision of the Town while ensuring the safety of the citizens.	All	High	Cary Planning	Local	Adoption 1996 Regular updates through area plans	Town Is in process of preparing new Community Plan incorporating all elements of existing Comp Plan. Adoption expected in 2015.
P-5	Southwest Area Plan – Lower densities of development are planned as the Town grows toward Jordan Lake.	All	High	Cary Planning	Local	Adoption in 2004 Perpetual implementation through standards in LDO	Continued implementation through review and approval of development plans. Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-6	Northwest Area Plan - Plan requires 200 foot buffers adjacent to the four major streams in the area west of NC 55 and north of Morrisville Parkway heading westward to Jordan Lake.	All	High	Cary Planning	Local	Adoption in 2003 Perpetual implementation through standards in LDO	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-7	Open Space Preservation – Existing Open Space Plan identifies and evaluates various land and open space resources throughout the ETJ and Urban Services Areas. The plan is used by Town staff to identify properties to be protected from development.	Flood	High	Cary Planning	Local	Adoption in 2002 Perpetual implementation through standards in LDO	Town Is in process of preparing new Community Plan incorporating all elements of existing Comp Plan. Adoption expected in 2015.
P-8	Building Code – In accordance with North Carolina General Statute, Chapter 160A, Article 19 the Town of Cary administers a Building Inspections program to uphold/enforce the 2009 NC State Building Code. These regulations provide guidance on design criteria for flood, roof snow load, wind design, wind speed, seismic design, eathering, frost line depth, termite infestation and decay.	All	High	Cary Inspections and Permits	Local	Completed	Continued implementation through review and approval of permits. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-9	Land Development Ordinance- The Town has an existing LDO which regulates development to ensure public health, safety and welfare of Cary residents and businesses.	All	High	Cary Planning	Local	Completed	Continued implementation through review and approval of development plans, permits and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-10	Provide adequate water supply through storage and interconnection with other public water systems.	Drought	High	Cary Public Works, Utilities and Water Resources	Local	Completed	See also ES-13. Drought or other conditions have not warranted activation of Response Plan. However Plan is in place if needed. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-11	Transportation Plan - Addresses disaster preparedness (evacuation) through road interconnectivity, pavement practices, signal preemption, etc.	All	High	Cary Facilities Design & Transportation Services, and Planning	Local	Completed implementation through standards in LDO	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-12	Floodplain Development Regulations – Ordinance restricts and/or prohibits uses which are dangerous to health, safety, and property due to water or erosion hazards which result in damaging increases in erosion or in flood heights or velocities.	Flood	High	Cary Water Resources	Local	Completed implementation through standards in LDO	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
P-13	Amend Town of Cary Land Development Ordinance and Zoning map as needed to begin implementation of the Chatham-Cary Joint Land Use Plan (if adopted).	All	High	Cary Planning	Local	Completed	Completed. Joint Plan adopted June 28, 2012.
P-14	Amend Code of Ordinances to restrict use of combustible landscape materials.	Wildfire	High	Cary Fire	Local	Completed	Deleted. Was previously completed in 2010.
P-15	If grant application is approved by FEMA, the Town will conduct a detailed study to determine the risk level of each residential structure in the identified floodplain areas and take actions to reduce the risk to those properties.	Flood	High	Cary Water Resources	Federal Grant	2018	Not implemented. Town applied for grant and was turned down. The town would like to implement if funding becomes available.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Natural Resource Protection							
NRP-1	Local Sedimentation and Erosion Control program approved by the NCDENR. Three staff members dedicated to this program.	Flood	High	Cary Water Resources	Local	Completed	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
NRP-2	Town requires installation of Best Management Practices to help with water quality and natural resource protection.	Flood	High	Cary Water Resources	Local	Completed	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
NRP-3	Forestry Practices - Existing program which requires a timbering plan within Town limits and ETJ.	Flood	Moderate	Cary Water Resources	Local	Completed	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
NRP-4	Wetlands Protection - Existing riparian, open space, and flood damage prevention ordinances restrict development along streams and in the floodplain thus restricting development in much of the Town's wetland areas.	Flood	Moderate	Cary Water Resources	Local	Completed, implementation through standards in LDO	Continued implementation through review and approval of development plans and public projects. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
NRP-5	Prepare a Stormwater Master Plan to help guide future stormwater management policies and procedures.	Flood	High	Cary Water Resources	Local	Completed	Completed. Adopted July 2013.
Structural Projects							
SP-1	Replace culverts on Holloway Street.	Flood	High	Cary Water Resources	Local	Completed	Completed. Project completed in early 2014.
SP-2	Replace culverts on Willow Street.	Flood	High	Cary Water Resources	Local	2015	In progress. Design in process. Schedule affected by workload.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
SP-3	Replace culverts on Woodland Drive.	Flood	High	Cary Water Resources	Local	2014	In progress. Bidding in process. Construction to begin July 2014. Schedule affected by workload.
SP-4	Replace culverts on Summer Lakes Drive	Flood	High	Cary Water Resources	Local	2015	New action. Design in process.
SP-5	Replace culverts on Kilarney Drive	Flood	High	Cary Water Resources	Local	2015	New action. Design in process.
SP-6	Replace culverts on Yubinaranda Circle	Flood	High	Cary Water Resources	Local	2015	New action. Design in process.
Emergency Services							
ES-1	Provide and enhance technical rescue capabilities throughout the Town.	All	High	Cary Fire	Local	2016	Funding approved for additional boat and structural collapse equipment
ES-2	Provide after-action report of emergency response to severe weather events in order to improve planning for future disasters.	All	High	Cary Fire, Water Resources, and Facilities Design & Transportation Services	Local	Perpetual- Post Event	A report is prepared and a debriefing meeting conducted after each significant event. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-3	Maintain a standard operating guideline to direct operational planning prior to anticipated weather emergencies.	All	High	Cary Fire	Local	Deleted	Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-4	Establish a relationship/partnership with the Renaissance Computing Institute (RENCI) to create a web-based tool capable of providing real-time flood data to emergency managers and historic data for future emergency response planning.	All	Low	Cary Fire and Technology Services	Local	2020	No action at this time. Low Priority due to limited staff and budget resources and limited applicability and risk. The town will attempt to develop in the coming years.
ES-5	Provide urban search and rescue services for structural collapse and similar emergencies.	All	High	Cary Fire	Local, State	Deleted	Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-6	Utilize visual warning barricades for vehicular and pedestrian traffic to block properties, roadways, etc. for the safety of the general public.	All	Moderate	Cary Public Works	Local	Completed	Public works staff utilized barricades whenever needed, typically a few times per year following heavy rain events, to ensure public safety. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-7	Continue to conduct disaster tabletop exercise program.	All	Low	Cary Fire, Public Works, and Utilities	Local	Completed	Mock hurricane and snowstorm events are conducted annually to prepare for hurricane season and winter. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-8	Critical Security Post Coverage – certain fixed sites identified for coverage during disasters – water treatment, municipal complex, wastewater treatment, etc. Vulnerable businesses and offices identified and contacted in event of rising waters.	All	Low	Cary Police	Local	Completed l	Businesses contacted during approximately 8-10 severe weather events during plan period. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-9	Emergency response plans are designed for officers to be assigned for security purposes until owners can take over the responsibility of securing premises.	All	Low	Cary Police	Local	Completed	Properties secured during approximately 5-7 severe weather events during plan period. Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-10	Counseling – Police psychologist and Critical Incident Stress Debriefing Team training to provide debriefing sessions for personnel.	All	Low	Cary Police	Local	Completed	Post-indent counseling and training provided for approximately 10 employees after critical incidents. Support continued with through post-traumatic support group. Incident represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-11	Utilize Water Emergency Response Plan in accordance with EPA mandate with wastewater emergency plan developed voluntarily.	All	High	Cary Utilities	Local	Completed	All required permits maintained with strong record of compliance Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-12	Maintain emergency electrical generators at all critical public utilities facilities.	All	High	Cary Utilities	Local	Completed	50 or more generators maintained at key locations. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-13	Maintain Water Shortage Response Plan in accordance with State Emergency Management Division and Division of Water Resources requirements for IBT certificate.	All	High	Cary Water Resources	Local	Completed	Drought or other conditions have not warranted activation of Response Plan. However Plan is in place if needed. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-14	Continue to develop emergency mutual aid water supply program.	Drought	Moderate	Cary Water Resources	Local, Regional	Completed	Mutual Aid Agreements now exist with Raleigh, Durham, and OWASA. Water was provided to Durham on short term basis in order to address water line break. Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-15	Maintain and enforce Water Conservation Policy and Program.	Drought	Moderate	Cary Water Resources	Local	Completed	See items ES-14 and PI-7. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
ES-16	Establish a relationship/partnership with the Renaissance Computing Institute (RENCI) to create a web-based tool capable of providing real-time data to emergency managers and historic data for future emergency response planning.	All	High	Cary Technology Services	Local	Deleted	Merged with ES-4.
Public Education and Awareness							
PEA-1	Town provides technical assistance to citizens that request help with drainage concerns.	Flood	Moderate	Cary Water Resources	Local	Completed	Assistance provided to approx 150-200 citizens per year. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
PEA-2	Stormwater staff provides the public with flood zone information via the telephone, e-mail or walk-in.	Flood	High	Cary Water Resources	Local	Completed	Information provided to approximately 50 callers or visitors per year. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
PEA-3	The Town provides environmental education on website by supplying information on flood hazards, development regulations, etc.	Flood	Moderate	Cary Water Resources	Local	Completed	Website is maintained and updated as new information becomes available. Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-4	The Town maintains a "stormwater hotline" for citizens to report flooding problems during non-working hours, weekends and holidays.	Flood	High	Cary Water Resources and Public Works	Local	Completed	Town has consistently responded to and tracked calls regarding flooding problems. Number of calls varies greatly from month to month depending and number, type and severity of weather events. *(Example, 22 in Feb 2014, 69 in April 2014)* Represented in Capability Assessment. Will remove from Mitigation actions in next update.
PEA-5	Town provides education programs at environmental education centers, e.g. Hemlock Bluffs.	Flood, Drought	Moderate	Cary Parks, Recreation and Cultural Resources	Local	Deleted	Action Item to be removed. Specific programs related to flood and drought not provided due to competing PCRC priorities. Education and information provided in other contexts through water Resources
PEA-6	Town provides flood maps for public use with staff available for public assistance.	Flood	High	Cary Water Resources	Local	Completed	Information provided to approximately 50 callers or visitors per year. Represented in Capability Assessment. Will remove from Mitigation actions in next update.
PEA-7	Town provides water conservation educational programs at Spring Days and Lazy Days Events held in the spring and late summer of every year.	All	Low	Cary Water Resources	Local	Completed	Information provided annually at Lazy Daze and Spring Daze festivals, and mailed each spring to all water customers at launch of summer campaign. Represented in Capability Assessment. Will remove from Mitigation actions in next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-8	Provide public outreach to owners of high-hazard dams and downstream property owners. Provide information to clarify notification process prior to water release.	Flood	High	Cary Water Resources and Public Works	Local	Completed	Completed. Issue adequately addressed by Land Quality Section (LQS) of NCDENR, which requires owners to have EAP, inspects dams, and provides inspection report to owners annually or biennially. Will remove this item from Mitigation actions in next update
PEA-9	Establish a relationship/partnership with the Renaissance Computing Institute (RENCI) to create a web-based tool that will allows users to view information about the risks of natural hazards, including floods, fires, dam breaks and winter storms, in specific areas of Wake County.	All	High	Cary Technology Services	Local	Deleted	Duplication – covered in ES-4
PEA-10	Regularly review and improve means of communicating and sharing information with citizens by utilizing emerging technologies where appropriate and cost effective.	All	High	All Town Departments	Local	Completed	Town now provides information via facebook, Youtube, and twitter, news release feed, email subscription service, local cable TV and apps related to transit service and sustainability.

Annex C
Town of Fuquay-Varina

This annex includes jurisdiction-specific information for the Town of Fuquay-Varina. It consists of the following five subsections:

- C.1 Town of Fuquay-Varina Community Profile
- C.2 Town of Fuquay-Varina Risk Assessment
- C.3 Town of Fuquay-Varina Vulnerability Assessment
- C.4 Town of Fuquay-Varina Capability Assessment
- C.5 Town of Fuquay-Varina Mitigation Strategy

C.1 TOWN OF FUQUAY-VARINA COMMUNITY PROFILE

C.1.1 Geography and the Environment

Fuquay-Varina is town located in Wake County in the state of North Carolina. It was initially incorporated as Fuquay Springs in 1909, but later merged with the neighboring town of Varina in 1963 to create the town in its current form.

Overall, Wake County is known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Summer temperatures generally venture into the 90s for highs and cool off to the 70s at night. Winter temperatures in can drop to below freezing but generally highs are in the 50s. Rainfall is most common in the summer months but occurs consistently throughout the year.

C.1.2 Population and Demographics

According to the 2010 Census, Fuquay-Varina has a population of 17,937 people. The jurisdiction has seen exceptional growth between 2000 and 2010, and the population density is almost 1,500 people per square mile. Population counts from the US Census Bureau for 1990, 2000, and 2010 are presented in **Table C.1**.

TABLE C.1: POPULATION COUNTS FOR FUQUAY-VARINA

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
FUQUAY-VARINA	4,562	7,898	17,937	127.11%

Source: US Census Bureau

The racial characteristics of the jurisdiction are presented in **Table C.2**. Whites make up the majority of the population in the jurisdiction, accounting for nearly 75 percent of the population.

TABLE C.2: DEMOGRAPHICS OF FUQUAY-VARINA

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
FUQUAY-VARINA	72.3%	19.7%	0.6%	7.4%	9.1%

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

C.1.3 Housing

According to the 2010 US Census, there are 7,325 housing units in Fuquay-Varina, the majority of which are single family homes or mobile homes. Housing information for the jurisdiction is presented in **Table C.3**.

TABLE C.3: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Seasonal Units, Percent (2010)	Median Home Value (2007-2011)
FUQUAY-VARINA	3,375	7,325	8.6%	$192,700

Source: US Census Bureau

C.1.4 Infrastructure

Transportation

There are several major roadways that residents of Fuquay-Varina utilize. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs, one of which is I-540/NC-540 which is a partly completed loop that connects the jurisdiction to many of the other municipalities. In addition to the Interstate, there are many major highways that residents of the municipality utilize. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways in the include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities

Electrical power in the jurisdiction is provided by two entities and Duke Energy and Wake Electric Membership Corporation with Duke Energy providing service to a majority of the service. Water and sewer service is provided by two main entities as well: The City of Raleigh Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

Community Facilities

There are a number of buildings and community facilities located throughout Fuquay-Varina. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 3 fire stations, 1 police station, and 10 public schools located within the jurisdiction. There is one medical care facility located in the municipality

Citizens also have access to several parks, including three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the county, including the American Tobacco Trail which is a rails to trails project that is open to a wide variety of non-motorized uses.

C.1.5 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land as parks. There are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the jurisdiction consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

C.1.6 Employment and Industry

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

C.2 TOWN OF FUQUAY-VARINA RISK ASSESSMENT

This subsection includes hazard profiles for each of the significant hazards identified in Section 4: *Hazard Identification* as they pertain to Fuquay-Varina. Each hazard profile includes a description of the hazard's location and extent, notable historical occurrences, and the probability of future occurrences. Additional information can be found in Section 5: *Hazard Profiles*.

C.2.1 Drought

Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, Fuquay-Varina has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that the county would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Historical Occurrences

According to the North Carolina Drought Monitor, Fuquay-Varina has had drought occurrences all of the last fourteen years (2000-2013). **Table C.4** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE C.4: HISTORICAL DROUGHT OCCURRENCES IN FUQUAY-VARINA

Abnormally Dry **Moderate Drought** **Severe Drought** **Extreme Drought** **Exceptional Drought**

	Fuquay-Varina
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that Fuquay-Varina has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

C.2.2 Extreme Heat

Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to any geographic or political boundaries. All of Fuquay-Varina is susceptible to extreme heat conditions.

Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Fuquay-Varina. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the region. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the county. The most centralized location is in Raleigh at North Carolina State University. **Table C.5** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table C.5: Average Maximum Temperature in Raleigh, Wake County

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

C.2.3 Hailstorm

Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Fuquay-Varina is uniformly exposed to severe thunderstorms; therefore, all areas are equally exposed to hail which may be produced by such storms.

Historical Occurrences

According to the National Climatic Data Center, 10 recorded hailstorm events have affected Fuquay-Varina since 1993.[1] **Table C.6** is a summary of the hail events in Fuquay-Varina. **Table C.7** provides detailed information about each event that occurred. In all, hail occurrences resulted in over $0 (2013 dollars) in property damages. Hail ranged in diameter from 0.75 inches to 1.75 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value.

Table C.6: Summary of Hail Occurrences in Fuquay-Varina

Location	Number of Occurrences	Property Damage (2013)
Fuquay-Varina	10	$0

[1] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Fuquay-Varina. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

Location	Number of Occurrences	Property Damage (2013)

Source: National Climatic Data Center

TABLE C.7: HISTORICAL HAIL OCCURRENCES IN FUQUAY-VARINA

	Date	Magnitude	Deaths/Injuries	Property Damage*
Fuquay-Varina				
FUQUAY SPGS	3/20/1998	0.75 in.	0/0	$0
FUQUAY SPGS	7/10/2003	1.75 in.	0/0	$0
FUQUAY SPGS	3/31/2004	0.75 in.	0/0	$0
VARINA	5/14/2006	1 in.	0/0	$0
FUQUAY SPGS	5/14/2006	1 in.	0/0	$0
FUQUAY SPGS	5/14/2006	1 in.	0/0	$0
FUQUAY SPGS	5/14/2006	1 in.	0/0	$0
FUQUAY SPGS	5/14/2006	1.25 in.	0/0	$0
FUQUAY SPGS	5/14/2006	1 in.	0/0	$0
FUQUAY SPGS	4/15/2007	1 in.	0/0	$0
FUQUAY SPGS	7/17/2007	0.75 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that Fuquay-Varina has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the county.

C.2.4 Hurricane and Tropical Storm

Location and Spatial Extent

Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Fuquay-Varina. The entire jurisdiction is equally susceptible to hurricane and tropical storms.

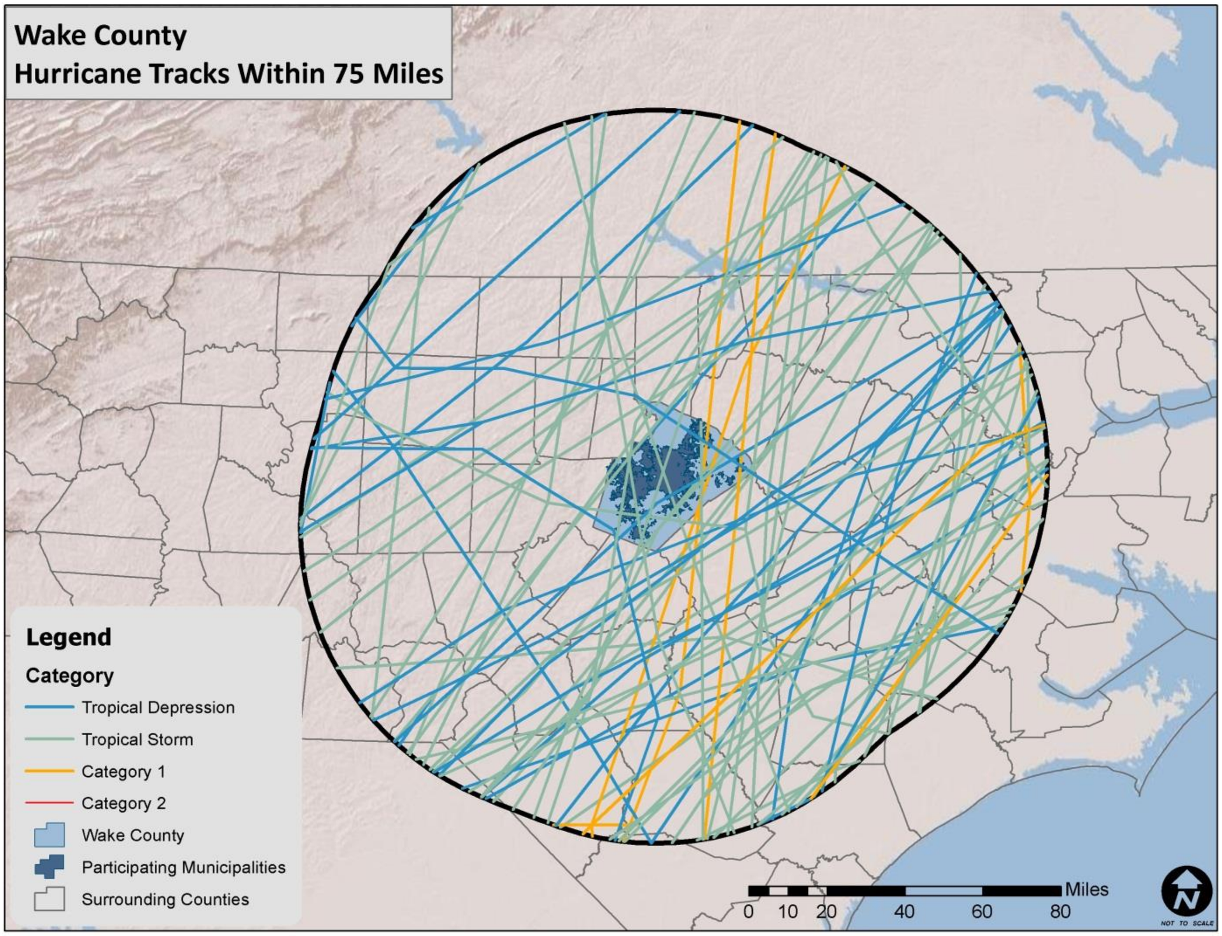
Historical Occurrences

According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[2] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms have traversed directly through Wake County as shown in **Figure C.1**. **Table C.8** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

[2] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

FIGURE C.1: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE C.8: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1882	NOT NAMED	53	Tropical Storm
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1959	CINDY	26	Tropical Depression
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression
2008	HANNA	40	Tropical Storm

Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Fuquay-Varina between 1950 and 2013. These storms are listed in **Table C.9** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE C.9: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made in 1996 (Hurricane Fran), 1999 (Hurricane Floyd), and 2003 (Hurricane Isabel) for the county.[3]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Tropical Storm Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

Probability of Future Occurrences
Given the inland location of the jurisdiction, it is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Fuquay-Varina. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the jurisdiction is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

[3] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

C.2.5 Lightning

Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Fuquay-Varina is uniformly exposed to lightning.

Historical Occurrences

According to the National Climatic Data Center, there has been one recorded lightning event in Fuquay-Varina since 1950, as listed in summary **Table C.10** and detailed in **Table C.11**.[4] However, it is certain that more lightning events have in fact impacted the jurisdiction. Many of the reported events are those that caused damage, and it should be expected that damages are likely much higher for this hazard than what is reported.

TABLE C.10: SUMMARY OF LIGHTNING OCCURRENCES IN FUQUAY-VARINA

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Fuquay-Varina	2	0/0	$95,703

Source: National Climatic Data Center

TABLE C.11: HISTORICAL LIGHTNING OCCURRENCES IN FUQUAY-VARINA

	Date	Deaths/Injuries	Property Damage*	Details
Fuquay-Varina				
FUQUAY SPGS	6/22/2001	0/0	$0	Lightning set fire to a house on Bennet Road. Damage amount unknown.

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Although there were not a high number of historical lightning events reported in Fuquay-Varina via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S. National Lightning Detection Network (NLDN®), Fuquay-Varina is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the jurisdiction.

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Fuquay-Varina. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

C.2.6 Severe Thunderstorm/High Wind

Location and Spatial Extent

A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Also, Fuquay-Varina typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Fuquay-Varina has uniform exposure to an event and the spatial extent of an impact could be large.

Historical Occurrences

Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011.[5] According to NCDC, there have been 21 reported thunderstorm/high wind events since 1994 for high wind and since 1950 for thunderstorms.[6] These events caused over $467,000 (2013 dollars) in damages and caused 4 injuries. **Table C.12** summarizes this information. **Table C.13** presents detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event.[7]

TABLE C. 12: SUMMARY OF THUNDERSTORM/HIGH WIND OCCURRENCES IN FUQUAY-VARINA

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Fuquay-Varina	21	0/4	$467,105

Source: National Climatic Data Center

TABLE C.13: HISTORICAL THUNDERSTORM/HIGH WIND OCCURRENCES IN FUQUAY-VARINA

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Fuquay-Varina					
Fuquay-Varina	1/7/1995	THUNDERSTORM WINDS	0 kts.	0/4	$426,721
FUQUAY SPGS	4/19/1998	TSTM WIND	50 kts.	0/0	$39,884
FUQUAY SPGS	7/7/2005	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	4/17/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	4/22/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	4/22/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	4/22/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	5/14/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	5/14/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	5/14/2006	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	6/11/2006	TSTM WIND	50 kts.	0/0	$0

[5] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.

[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional thunderstorm events have occurred in Fuquay-Varina. As additional local data becomes available, this hazard profile will be amended.

[7] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
FUQUAY SPGS	3/2/2007	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	6/29/2007	THUNDERSTORM WIND	54 kts.	0/0	$0
VARINA	8/21/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
VARINA	9/14/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
VARINA	9/14/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
VARINA	9/14/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
VARINA	9/14/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
VARINA	7/23/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
VARINA	7/9/2012	THUNDERSTORM WIND	50 kts.	0/0	$530

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire jurisdiction.

C.2.7 Tornado

Location and Spatial Extent

Tornadoes occur throughout the state of North Carolina, and thus in Fuquay-Varina. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Fuquay-Varina is uniformly exposed to this hazard.

Historical Occurrences

Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there have been 0 recorded tornado events in Fuquay-Varina since 1956 (**Table C.14**), resulting in $0 (2013 dollars) in property damages.[8] Detailed information on these events can be found in **Table C.15**. However, several tornadoes have occurred in nearby areas and an F5 event is possible. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is likely that a high number of occurrences have gone unreported over the past 50 years.

[8] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Fuquay-Varina. As additional local data becomes available, this hazard profile will be amended.

TABLE C.14: SUMMARY OF TORNADO OCCURRENCES IN FUQUAY-VARINA

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Fuquay-Varina	0	0/0	$0

Source: National Climatic Data Center

TABLE C.15: HISTORICAL TORNADO IMPACTS IN KNIGHTDALE

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Fuquay-Varina					
None reported					

*Property Damage is reported in 2013 dollars.
Source: NCDC

2011 Tornadoes- April 16, 2011
In 2011, the county and all of its jurisdictions were impacted by one of the worst tornado-related events in the county's recorded history. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries.

Probability of Future Occurrences
According to historical information, tornado events are not an annual occurrence for the jurisdiction. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Fuquay-Varina experience a direct tornado strike. The probability of future tornado occurrences affecting Fuquay-Varina is likely (10-100 percent annual probability).

C.2.8 Winter Storm and Freeze

Location and Spatial Extent
Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Fuquay-Varina is accustomed to smaller scale severe winter weather conditions and often receives severe winter weather during the winter months. Given the atmospheric nature of the hazard, the entire jurisdiction has uniform exposure to a winter storm.

Historical Occurrences
Severe winter weather has resulted in six disaster declarations in Fuquay-Varina. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. [9] According to the National Climatic Data Center, there have been no recorded winter storm events in

[9] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.

Fuquay-Varina since 1993 (**Table C.16**).[10] These events resulted in $0 (2013 dollars) in damages. However, there have been 28 recorded countywide events and most severe winter weather events are only recorded at the county level.

TABLE C.16: SUMMARY OF WINTER STORM EVENTS IN FUQUAY-VARINA

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Fuquay-Varina	0	0/0	$0

Source: National Climatic Data Center

There have been several severe winter weather events in Fuquay-Varina. The text below describes one of the major events and associated impacts on the county. Similar impacted can be expected with severe winter weather.

1996 Winter Storm
This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and power outages. Furthermore, citizens may resort to using inappropriate heating devices that could to fire or an accumulation of toxic fumes.

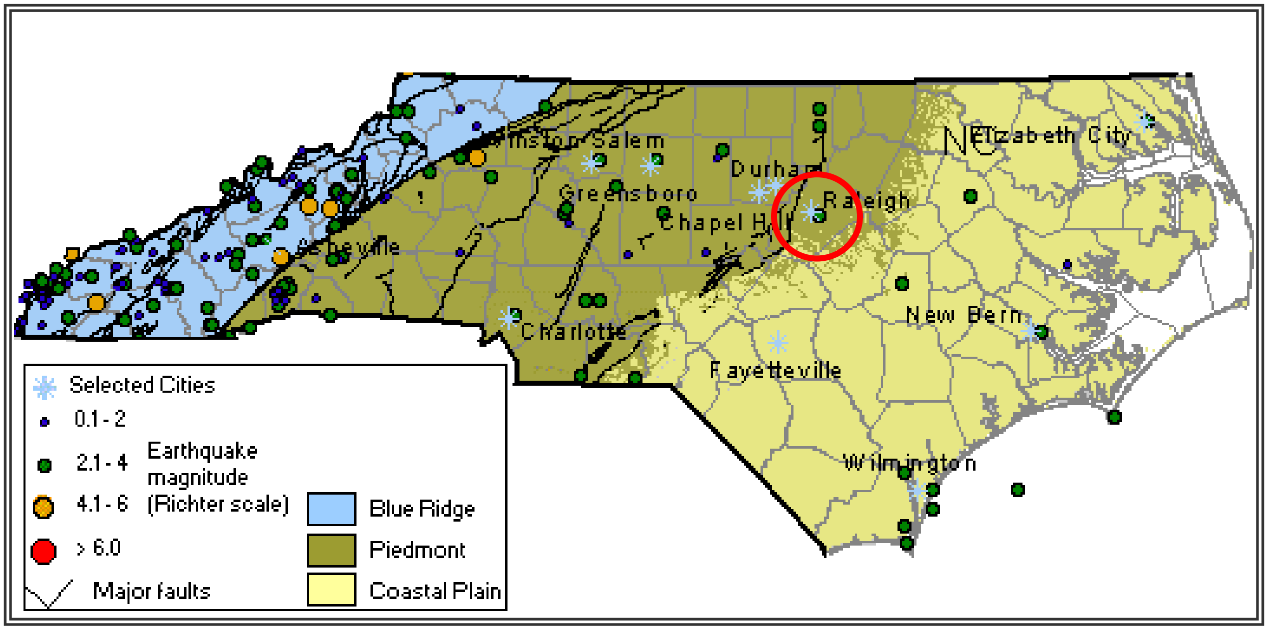
Probability of Future Occurrences
Winter storm events will remain a somewhat regular occurrence in Fuquay-Varina due to location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

C.2.9 Earthquake

Location and Spatial Extent
Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina. **Figure C.2** is a map showing geological and seismic information for North Carolina.

[10] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional winter storm conditions have affected Fuquay-Varina.

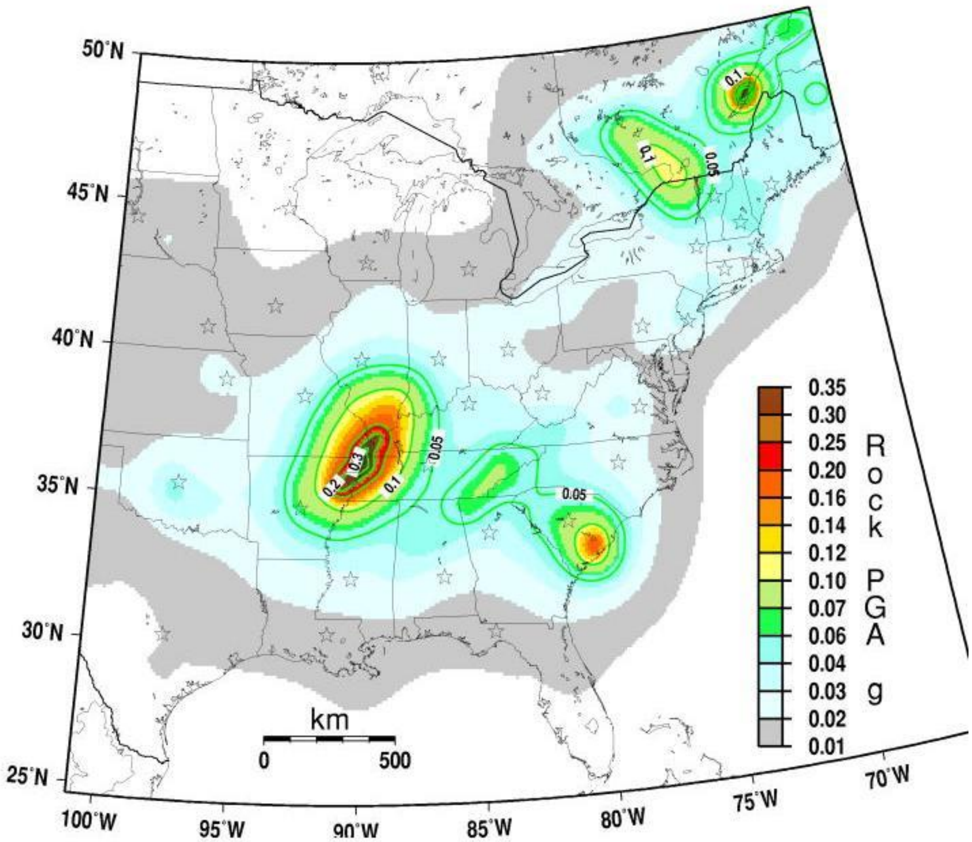
FIGURE C.2: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure C.3 shows the intensity level associated with Fuquay-Varina, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Fuquay-Varina lies within an approximate zone of level "2" to "3" ground acceleration. This indicates that the county exists within an area of moderate seismic risk.

FIGURE C.3: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

Historical Occurrences

Although no earthquakes are known to have occurred directly in Fuquay-Varina since 1874, several have occurred in the county and affected the municipality. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table C.17** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table C.18** presents a detailed occurrence of each event including the date, distance for the epicenter, and Modified Mercalli Intensity (if known).[11]

TABLE C.17: SUMMARY OF SEISMIC ACTIVITY IN FUQUAY-VARINA

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Fuquay-Varina	--	--	--

Source: National Geophysical Data Center

[11] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

TABLE C.18: SIGNIFICANT SEISMIC EVENTS IN FUQUAY-VARINA (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI (magnitude)
Fuquay-Varina				
None reported				

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Fuquay-Varina, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table C.19.**

TABLE C.19: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 - 1	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928*	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957*	Buncombe County, NC	3.7	VI	VI
11/24/1957*	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973*	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Fuquay-Varina occurrences.
** Conflicting reports on this event, intensity in North Carolina could have been either V or VI
Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Fuquay-Varina is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. The annual probability level for the county is estimated between 1 and 10 percent (possible).

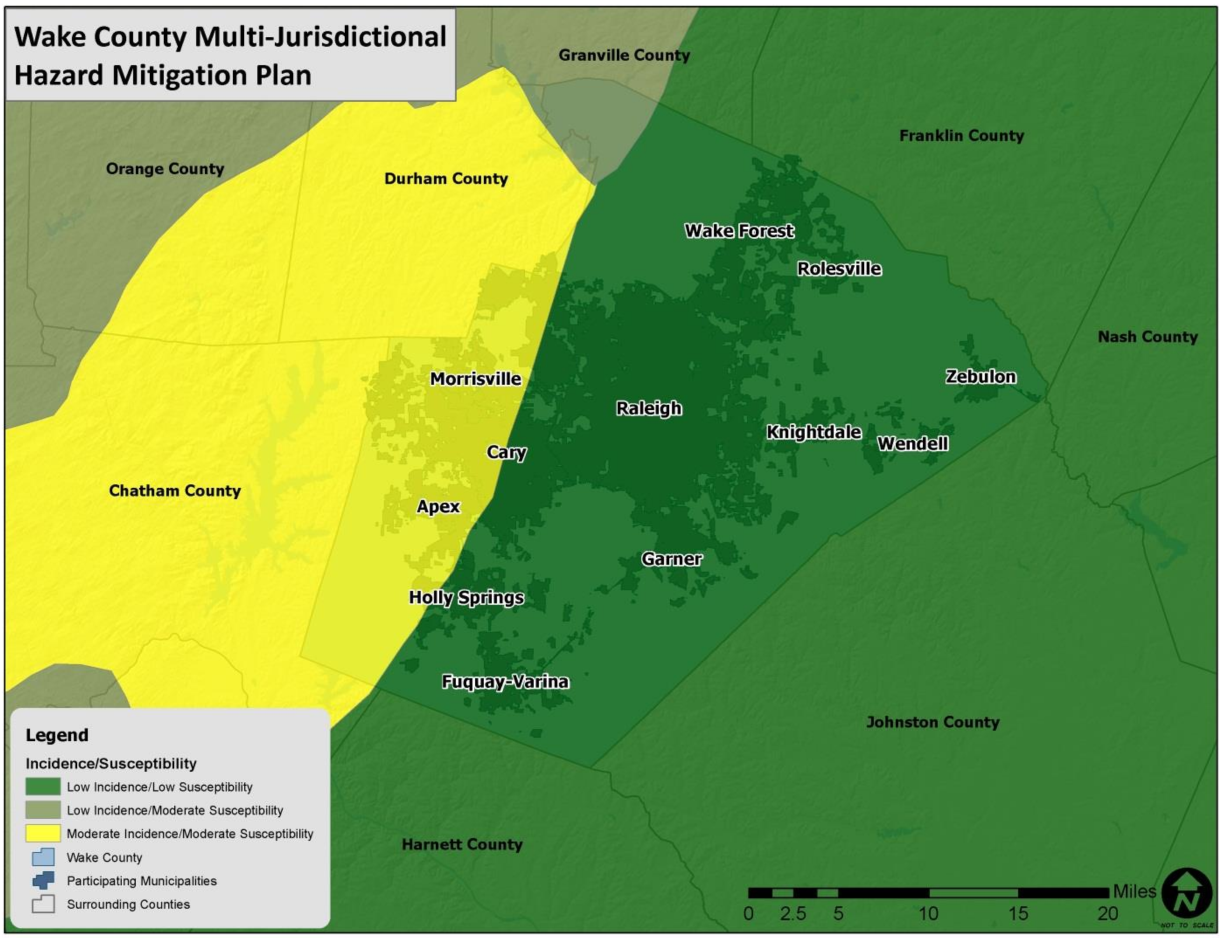
C.2.10 Landslide

Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Fuquay-Varina, although the overall risk is relatively low.

According to **Figure C.4** below, the majority of the county has low landslide activity. However there is a small area along the western border of the county that has a moderate incidence and moderate susceptibility. In all other areas (including all of Fuquay-Varina), there is low susceptibility.

FIGURE C.4: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

Historical Occurrences

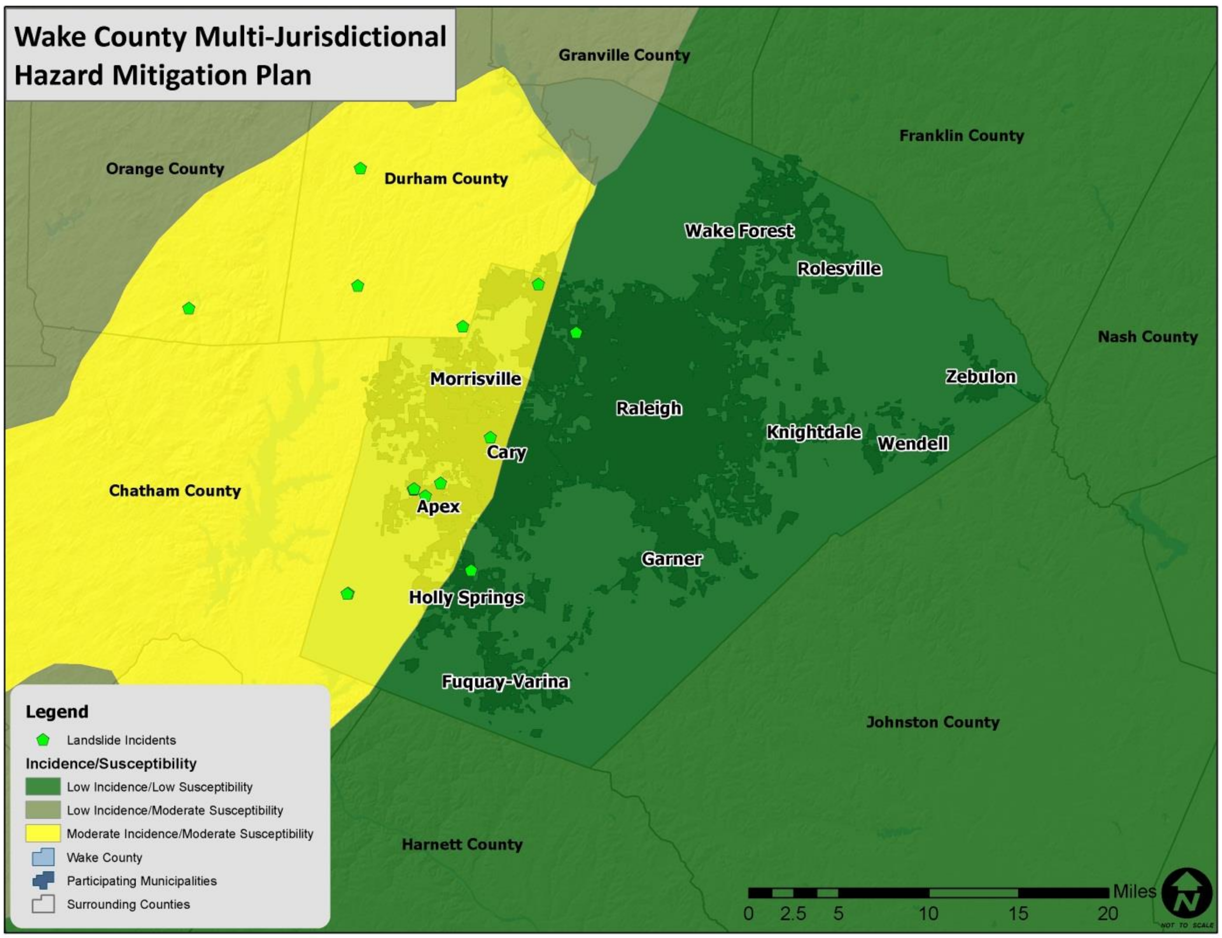
Steeper topography in some areas of Fuquay-Varina make the planning area susceptible to landslides. Most landslides are caused by heavy rainfall in the area. Building on steep slopes that was not previously possible also contributes to risk. **Table C.20** presents a summary of the landslide occurrence events as provided by the North Carolina Geological Survey[12]. The georeferenced locations of the landslide events presented in the aforementioned tables are presented in **Figure C.5**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred in Fuquay-Varina.

TABLE C.20: SUMMARY OF LANDSLIDE ACTIVITY IN FUQUAY-VARINA

Location	Number of Occurrences
Fuquay-Varina	0

Source: North Carolina Geological Survey

FIGURE C.5: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for

[12] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Fuquay-Varina have greater risk than others given factors such as steepness on slope and modification of slopes.

C.2.11 Dam and Levee Failure

Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table C.21** explains these classifications.

TABLE C.21: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

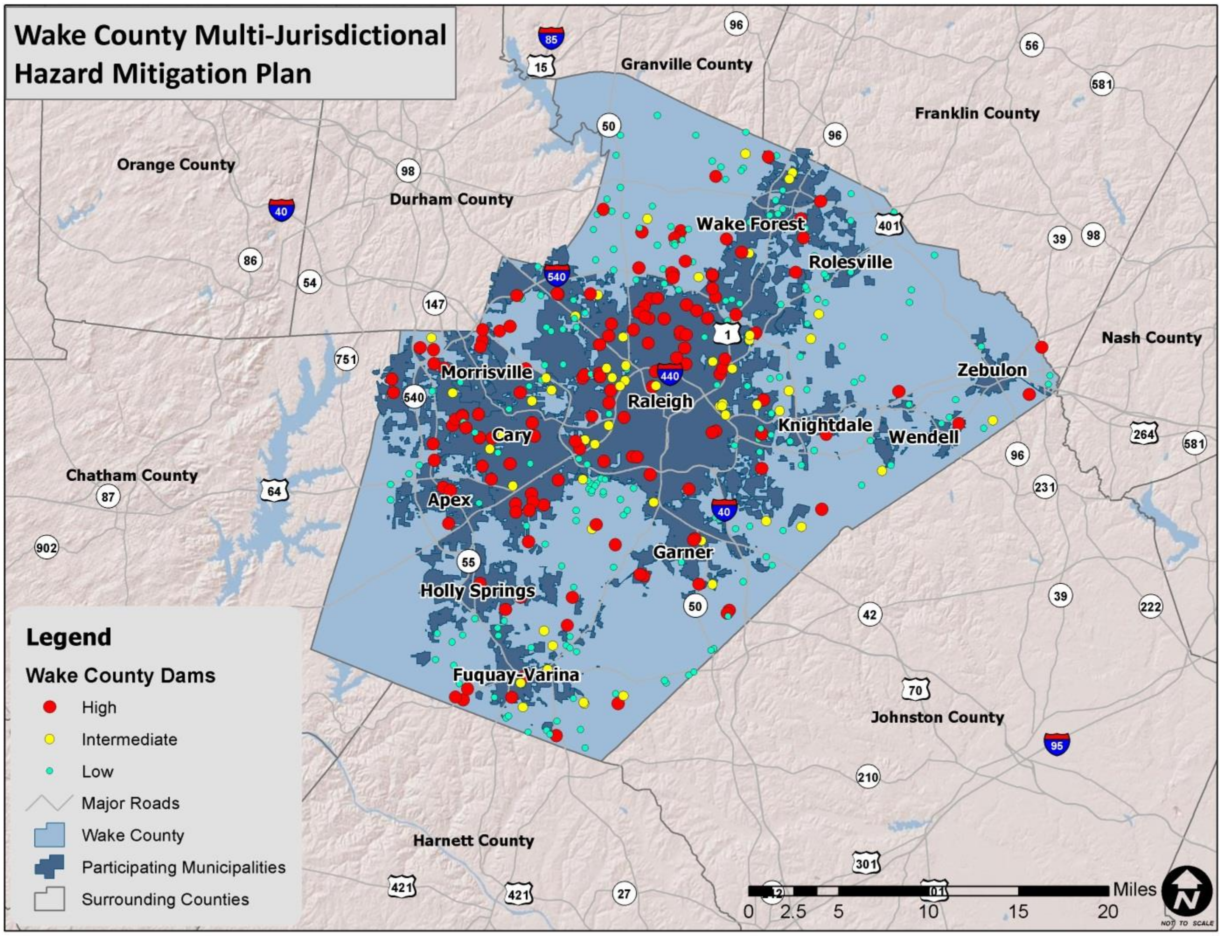
Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

According to the North Carolina Division of Land Management there are 8 dams in Fuquay-Varina.[13] **Figure C.6** shows the dam location and the corresponding hazard ranking for each. Of these dams, two are classified as high hazard potential. These high hazard dams are listed in **Table C.22**.

[13] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE C.6: WAKE COUNTY DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE C.22: FUQUAY-VARINA HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Fuquay-Varina				
Parker Lake Dam	High	0	75	Private
Jones Pond Dam	High	3	19	Private

Source: North Carolina Division of Land Resources, 2012

It should also be noted that the North Carolina dam classification regulations were recently updated. As a result of the change, more dams are generally classified as high hazard.

Historical Occurrences

No dam breaches were reported in Fuquay-Varina. However, several breach scenarios in the jurisdiction could cause substantial damage.

Probability of Future Occurrences

Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

C.2.12 Erosion

Location and Spatial Extent

Erosion in Fuquay-Varina is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Fuquay-Varina soils have greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Fuquay-Varina, particularly along the banks of rivers and streams, but it is not an extreme threat. No areas of concern were reported by the planning committee.

Historical Occurrences

Several sources were vetted to identify areas of erosion in Fuquay-Varina. This includes searching local newspapers, interviewing local officials, and reviewing the previous hazard mitigation plan. Little information could be found and erosion was not addressed in the previous Fuquay-Varina hazard mitigation plan.

Probability of Future Occurrences

Erosion remains a natural, dynamic, and continuous process for Fuquay-Varina, and it will continue to occur. The annual probability level assigned for erosion is possible (between 1 and 10 percent annually).

C.2.13 Flood

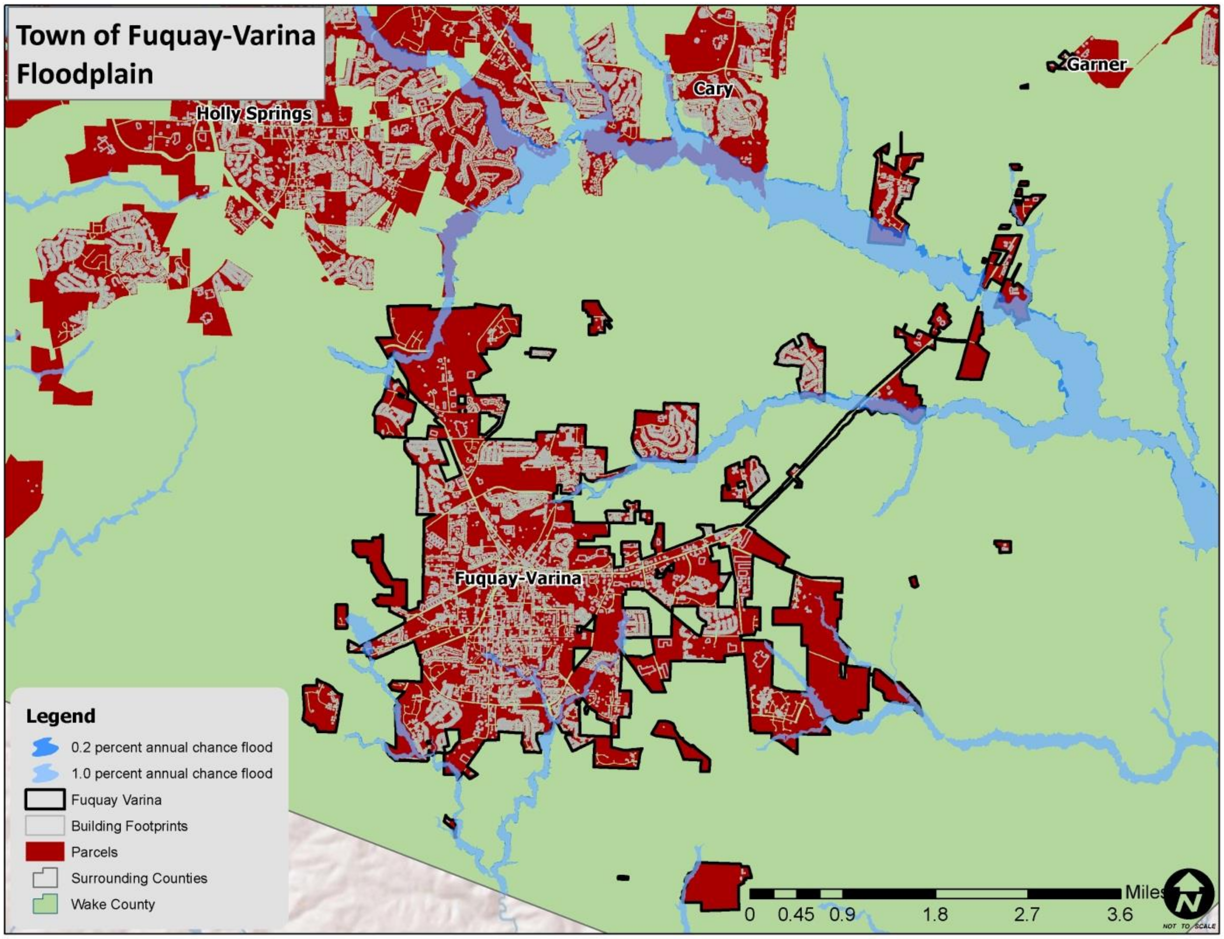
Location and Spatial Extent

There are areas in Fuquay-Varina that are susceptible to flood events. Special flood hazard areas in the jurisdiction were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[14] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 12 square miles that make up Fuquay-Varina, there are 0.54 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain).

These flood zone values account for 4.5 percent of the total land area in Fuquay-Varina. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas. **Figure C.7** illustrates the location and extent of currently mapped special flood hazard areas for Fuquay-Varina based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.

[14] The county-level DFIRM data used for Fuquay-Varina were updated in 2010.

FIGURE C.7: SPECIAL FLOOD HAZARD AREAS IN FUQUAY-VARINA



Source: Federal Emergency Management Agency

Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported a total of 3 events in Fuquay-Varina since 1993.[15] A summary of these events is presented in **Table C.23**. These events accounted for over $0 (2013 dollars) in property damage in the county.[16] Specific information on flood events, including date, type of flooding, and deaths and injuries, can be found in **Table C.24**.

TABLE C.23: SUMMARY OF FLOOD OCCURRENCES IN FUQUAY-VARINA

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Fuquay-Varina	3	0/0	$0

Source: National Climatic Data Center

[15] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.
[16] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

TABLE C.24: HISTORICAL FLOOD EVENTS IN FUQUAY-VARINA

	Date	Type	Deaths/ Injuries	Property Damage*
Fuquay-Varina				
FUQUAY SPGS	8/4/2000	FLASH FLOOD	0/0	$0
FUQUAY SPGS	7/17/2003	FLASH FLOOD	0/0	$0
FUQUAY SPGS	6/4/2004	FLASH FLOOD	0/0	$0

Source: National Climatic Data Center

Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there has been 1 flood loss reported in Fuquay-Varina through the National Flood Insurance Program (NFIP) since 1978. A summary of these figures for the jurisdiction is provided in **Table C.25**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that additional instances of flood loss in Fuquay-Varina were either uninsured, denied claims payment, or not reported.

TABLE C.25: SUMMARY OF INSURED FLOOD LOSSES IN FUQUAY-VARINA

Location	Flood Losses	Claims Payments
Fuquay-Varina	1	$5,783

Source: FEMA, NFIP

Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

As of July 2013, there are 0 non-mitigated repetitive loss properties located in Fuquay-Varina, which accounted for 0 losses and $0 in claims payments under the NFIP. Without mitigation, repetitive loss properties will likely continue to experience flood losses. **Table C.26** presents detailed information on repetitive loss properties and NFIP claims and policies for Fuquay-Varina.

TABLE C.26: SUMMARY OF REPETITIVE LOSS PROPERTIES IN FUQUAY-VARINA

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Fuquay-Varina	0	-	0	$0	$0	$0	$0

Source: National Flood Insurance Program

Probability of Future Occurrences

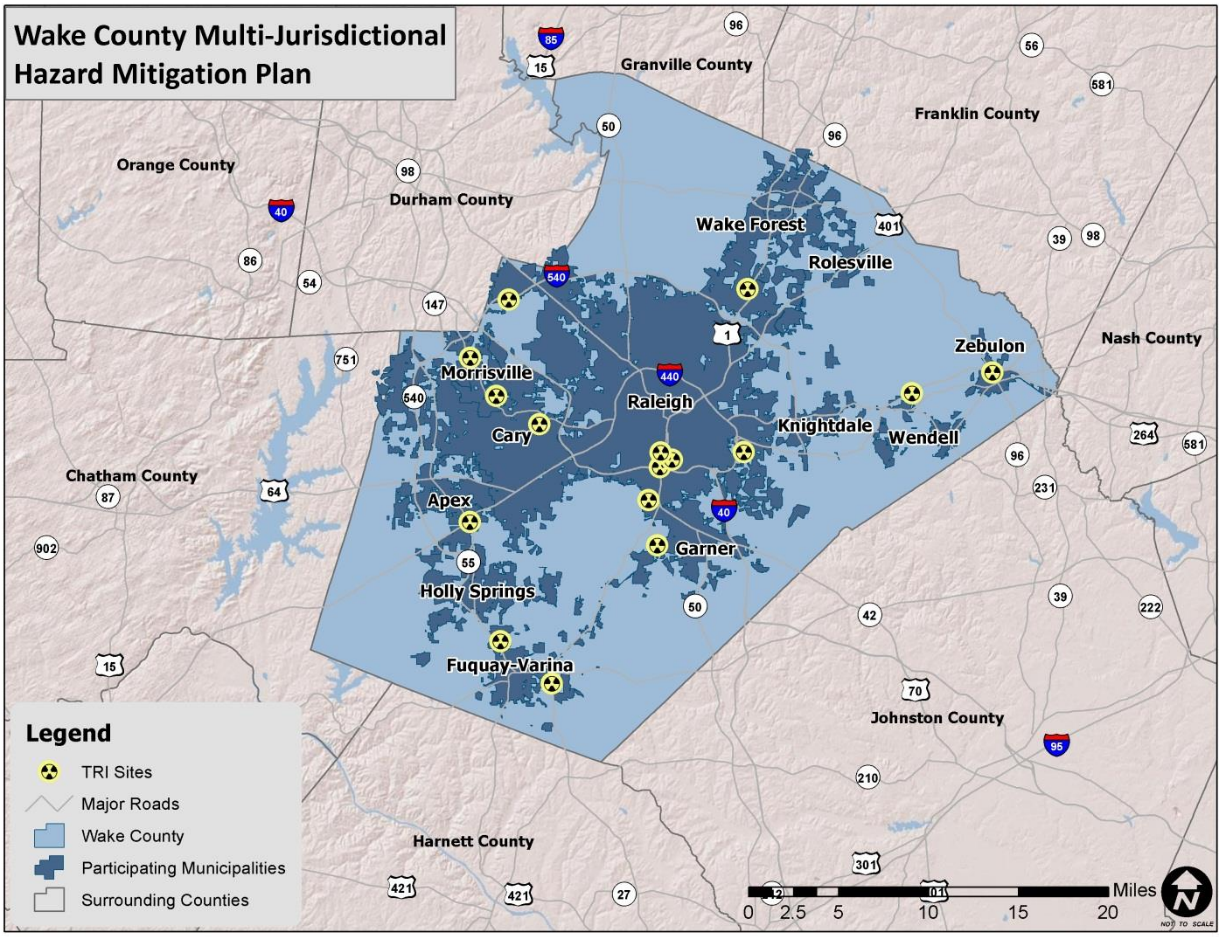
Flood events will remain a threat in areas prone to flooding in Fuquay-Varina, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability) The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above**,** which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

C.2.14 Hazardous Materials Incidents

Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Fuquay-Varina has no TRI sites as shown in **Figure C.8.**

FIGURE C.8: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the jurisdiction via roadways and rail. All roads that permit hazardous material transport are considered potentially at risk to an incident.

Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table C.27 presents detailed information on historic HAZMAT incidents reported in Fuquay-Varina.

TABLE C.27: SUMMARY OF HAZMAT INCIDENTS IN FUQUAY-VARINA

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Fuquay-Varina							
None reported							

Source: USDOT PHMSA

Probability of Future Occurrences

Although there are no toxic release inventory sites in Fuquay-Varina, there are several roadways and rails that transport hazardous materials, so it is possible that a hazardous material incident may occur in the jurisdiction (between 1 percent and 10 percent annual probability). Local officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

C.2.15 Wildfire

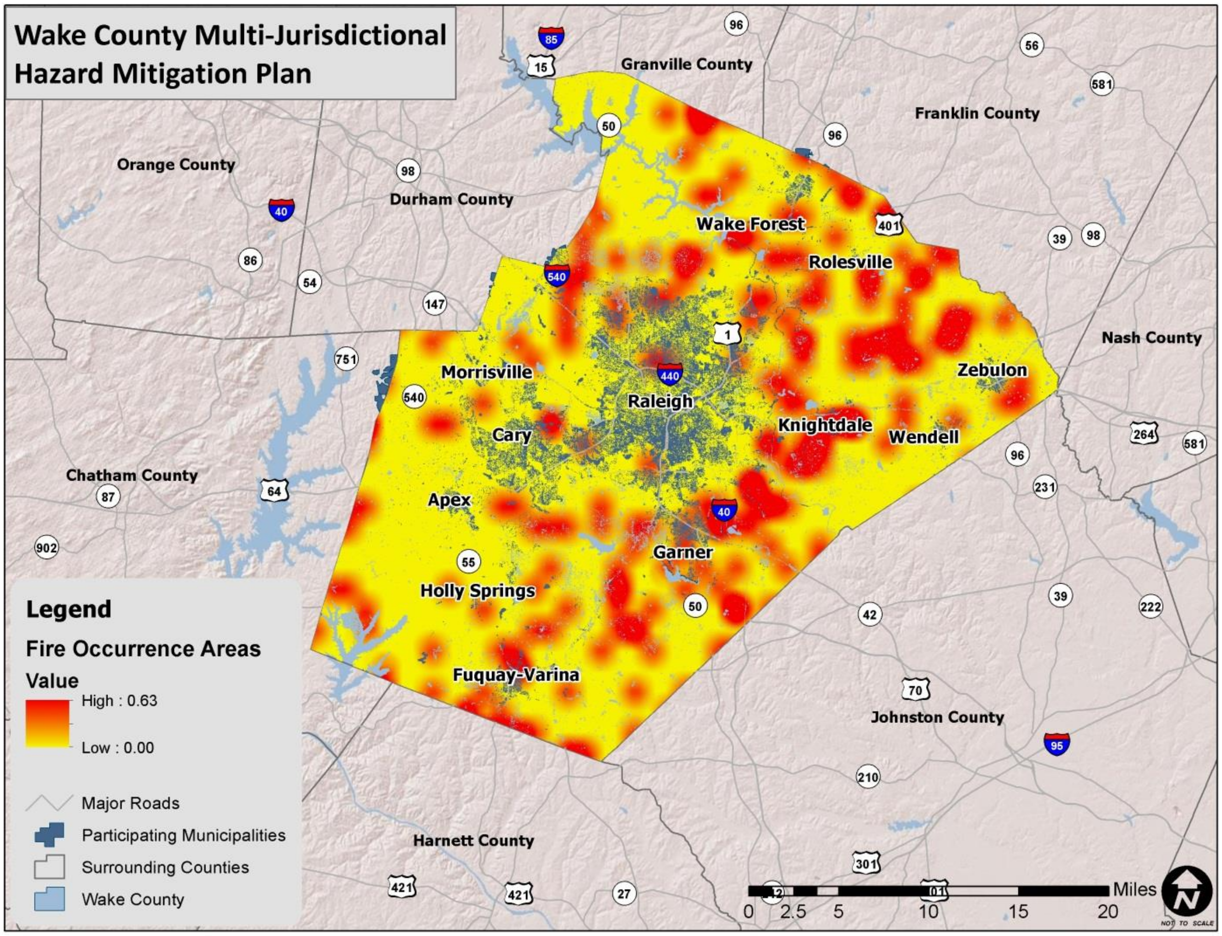
Location and Spatial Extent

The entire jurisdiction is at some risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas.

Historical Occurrences

Figure C.9 shows the Fire Occurrence Areas (FOA) in Fuquay-Varina based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. Therefore, even areas classified as at relatively high risk within the county are a relatively low risk compared to other areas of the state.

FIGURE C.9: HISTORIC WILDFIRE EVENTS IN FUQUAY-VARINA



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of 16 wildfires annually which burn an average of 98 acres per year. The data indicates that most of these fires are small, averaging six acres per fire. **Table C.28** lists the number of reported wildfire occurrences in the county between the years 2003 and 2012.

TABLE C.28: HISTORICAL WILDFIRE OCCURRENCES IN FUQUAY-VARINA

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Fuquay-Varina. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Fuquay-Varina for future wildfire events is possible (a 1 and 10 percent annual probability).

C.2.16 Nuclear Accident

Location and Spatial Extent

The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station.

Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 “Alerts” and 28 “Notice of Unusual Events” since 1986, which are shown in **Table C.29**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table C.29: SHEARON HARRIS EMERGENCY DECLARATION HISTORY

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on “B” Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).

Emergency Declaration	Date	Description
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of “A” Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - “B” diesel generator was being worked on; in accordance with test procedures, “A” diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported “Notice of Unusual Events” since 1986, which is shown in **Table C.30**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table C.30: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Probability of Future Occurrences

A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

C.2.17 Terror Threat

Location and Spatial Extent

A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table C.31** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

TABLE C.31 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food	▪ Government Facilities
▪ Banking and Finance	▪ Healthcare and Public Health
▪ Chemical	▪ Information Technology
▪ Commercial Facilities	▪ National Monuments and Icons
▪ Communications	▪ Nuclear Reactors, Materials, and Waste
▪ Critical Manufacturing	▪ Postal and Shipping
▪ Dams	▪ Transportation Systems
▪ Defense Industrial Base	▪ Water
▪ Emergency Services	
▪ Energy	

Historical Occurrences

Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

Probability of Future Occurrences

Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

C.2.18 Conclusions on Hazard Risk

The hazard profiles presented above were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and

experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

Hazard Extent

Table C.32 describes the extent of each natural hazard identified for Fuquay-Varina. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE C.32 EXTENT OF FUQUAY-VARINA HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page C:4). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Fuquay-Varina has received this ranking three times over the fourteen year reporting period.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Fuquay-Varina was 1.75 inches. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), Fuquay-Varina is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Thunderstorm Wind/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Fuquay-Varina was reported at 54 knots (approximately 62 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). There have been no recorded tornados in Fuquay-Varina, but an F5 is possible.
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Fuquay-Varina. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is low in Fuquay-Varina.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). Of the 8 dams in Fuquay-Varina, 2 are classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records located in Fuquay-Varina.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 4.5 percent of the total land area in Fuquay-Varina. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second.
Other Hazards	
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incident reported in the region is 75 LGA released on the highway in Raleigh. It should be noted that larger events are possible.
Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).

Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

Priority Risk Index Results

In order to draw some meaningful planning conclusions on hazard risk for Fuquay-Varina, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). More information on the PRI and how it was calculated can be found in Section 5.20.2.

Table C.33 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups and Coordinating Committee. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE C.33: SUMMARY OF PRI RESULTS FOR FUQUAY-VARINA

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	**2.5**
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	**2.4**
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	**2.5**
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	**2.1**
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	**3.1**
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.7**
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	**2.5**
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2**
Landslide	Unlikely	Minor	Small	Less than 6 hours	Less than 6 hours	**1.5**
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	**1.8**
Flood	Likely	Critical	Small	6 to 12 hours	Less than 1 week	**2.8**
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	**2**
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	**2.6**
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	**2.4**

C.2.16 Final Determinations on Hazard Risk

The conclusions drawn from the hazard profiling process for Fuquay-Varina, including the PRI results and input from the Regional Work Groups and Coordinating Committee, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table C.34**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Fuquay-Varina. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment* and below in Section C.3. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE C.34: CONCLUSIONS ON HAZARD RISK FOR FUQUAY-VARINA

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Nuclear Accident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

C.3 TOWN OF FUQUAY-VARINA VULNERABILITY ASSESSMENT

This subsection identifies and quantifies the vulnerability of Fuquay-Varina to the significant hazards previously identified. This includes identifying and characterizing an inventory of assets in the county and assessing the potential impact and expected amount of damages caused to these assets by each identified hazard event. More information on the methodology and data sources used to conduct this assessment can be found in Section 6: *Vulnerability Assessment*.

C.3.1 Asset Inventory

Table C.35 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for Fuquay-Varina (study area of vulnerability assessment).[17]

TABLE C.35: IMPROVED PROPERTY IN FUQUAY-VARINA

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Fuquay-Varina	8,830	$2,003,114,842	7,048	$1,500,117,328

Table C.36 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in Fuquay-Varina. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. In addition, a list of secondary facilities was created to recognize the importance of these facilities in the event of a disaster. These facilities were not mapped, but it is important to recognize that they could be potentially impacted by nearly any of the identified hazards, especially those that are atmospheric or have no specific spatial delineation.

All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure C.10** shows the locations of the primary critical facilities in Wake County. **Table C.48**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility. As noted previously, this list is not all-inclusive and only includes information provided by the local government.

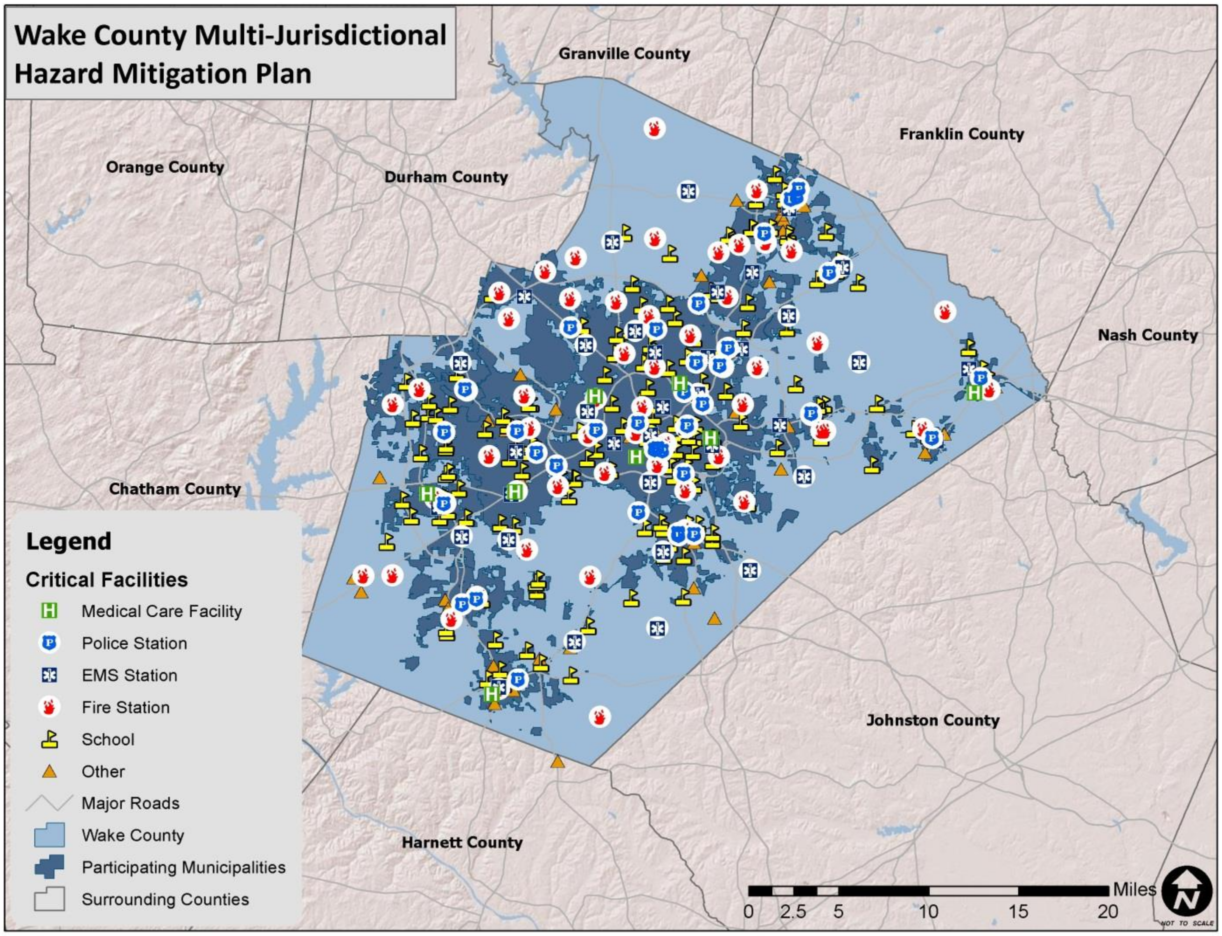
TABLE C.36: CRITICAL FACILITY INVENTORY IN FUQUAY-VARINA

Location	Fire Stations	Police Stations	EMS Stations	Medical Care Facilities	Schools	Other
Fuquay-Varina	1	1	1	1	8	6

Source: Local Governments

[17] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

FIGURE C.10: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: Local Governments

C.3.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Fuquay-Varina that are potentially at risk to these hazards.

Table C.37 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, limited the results to county-wide estimates. The total population in Fuquay-Varina according to Census data is 17,937 persons. Additional population estimates are presented above in Section C.1.

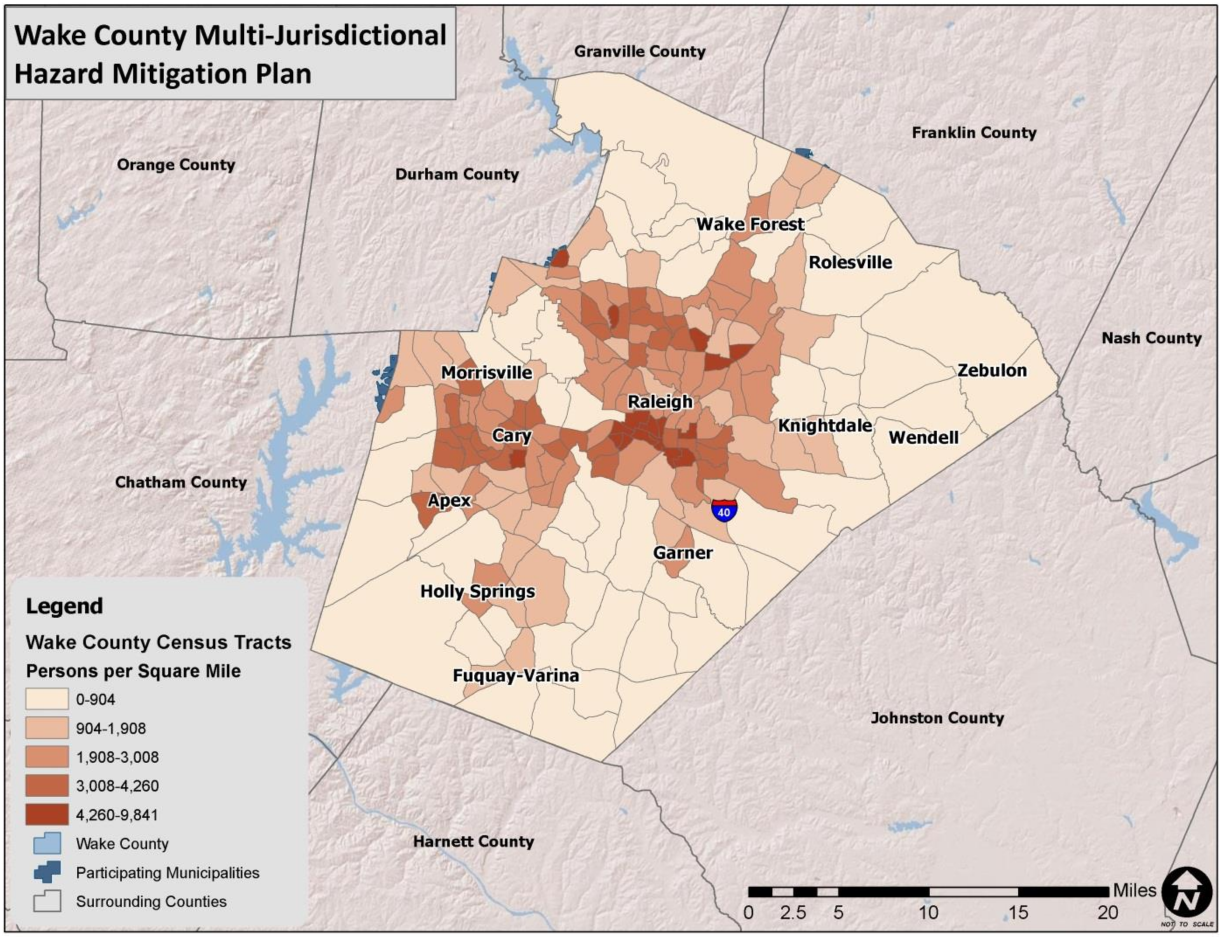
TABLE C.37: TOTAL POPULATION IN FUQUAY-VARINA

Location	Total 2010 Population
Fuquay-Varina	17,937

Source: U.S. Census 2010

In addition, **Figure C.11** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[18]

FIGURE C.11: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

C.3.3 Vulnerability Assessment Results

As noted in Section 6: *Vulnerability Assessment*, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results, specific to Fuquay-Varina, are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total county exposure, and thus risk, was presented in **Table C.35**.

The annualized loss estimate for all hazards is presented at the end of this section in **Table C.47.**

The hazards presented in this section include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

[18] Population by census block was not available at the time this plan was completed.

Hurricane and Tropical Storm

Historical evidence indicates that Fuquay-Varina has a significant risk to the hurricane and tropical storm hazard. Several tracks have come near or traversed through the county, as shown and discussed in Section C.2.4.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes, and high winds and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table C.38.** Only losses to buildings are reported, in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE C.38: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table C.39.**

TABLE C.39: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Fuquay-Varina	74.2	83.4	102.3	109.0

Source: Hazus-MH 2.1

Social Vulnerability

Given equal susceptibility across the county, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Fuquay-Varina, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table C.48** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Fuquay-Varina. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

Earthquake

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table C.40** summarizes the findings.

TABLE C.40: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability

It can be assumed that all existing future populations are at risk to the earthquake hazard.

Critical Facilities

The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table C.48**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Fuquay-Varina. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

Landslide

In order to complete the vulnerability assessment for landslides in Fuquay-Varina, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section C.2.10), tax parcel and building footprint data, and GIS analysis. **Table C.41** presents the potential at-risk property where available. All areas of Fuquay-Varina are identified as low incidence areas by the USGS landslide data. Since there were no high incidence levels in the county, the moderate incidence level was used to identify different areas of concern for the analysis below.

TABLE C. 41: TOTAL POTENTIAL AT-RISK PARCELS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	**Moderate**		
Fuquay-Varina	0	0	$0

Source: USGS

Social Vulnerability
Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides.

Critical Facilities
No critical facilities are located in a moderate susceptibility area. A list of specific critical facilities and their associated risk can be found in **Table C.48** at the end of this section.

In conclusion, a landslide has the potential to impact existing and future buildings, facilities, and populations in Fuquay-Varina, though some areas are at a higher risk than others due to a variety of factors. For example, steep slopes and modified slopes bear a greater risk than flat areas. Specific vulnerabilities for county assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

Flood
Historical evidence indicates that Fuquay-Varina is susceptible to flood events. A total of 3 flood events have been reported by the National Climatic Data Center resulting in $0 in damages. On an annualized level, these damages amounted to $0 for Fuquay-Varina.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for the county. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table C.42** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

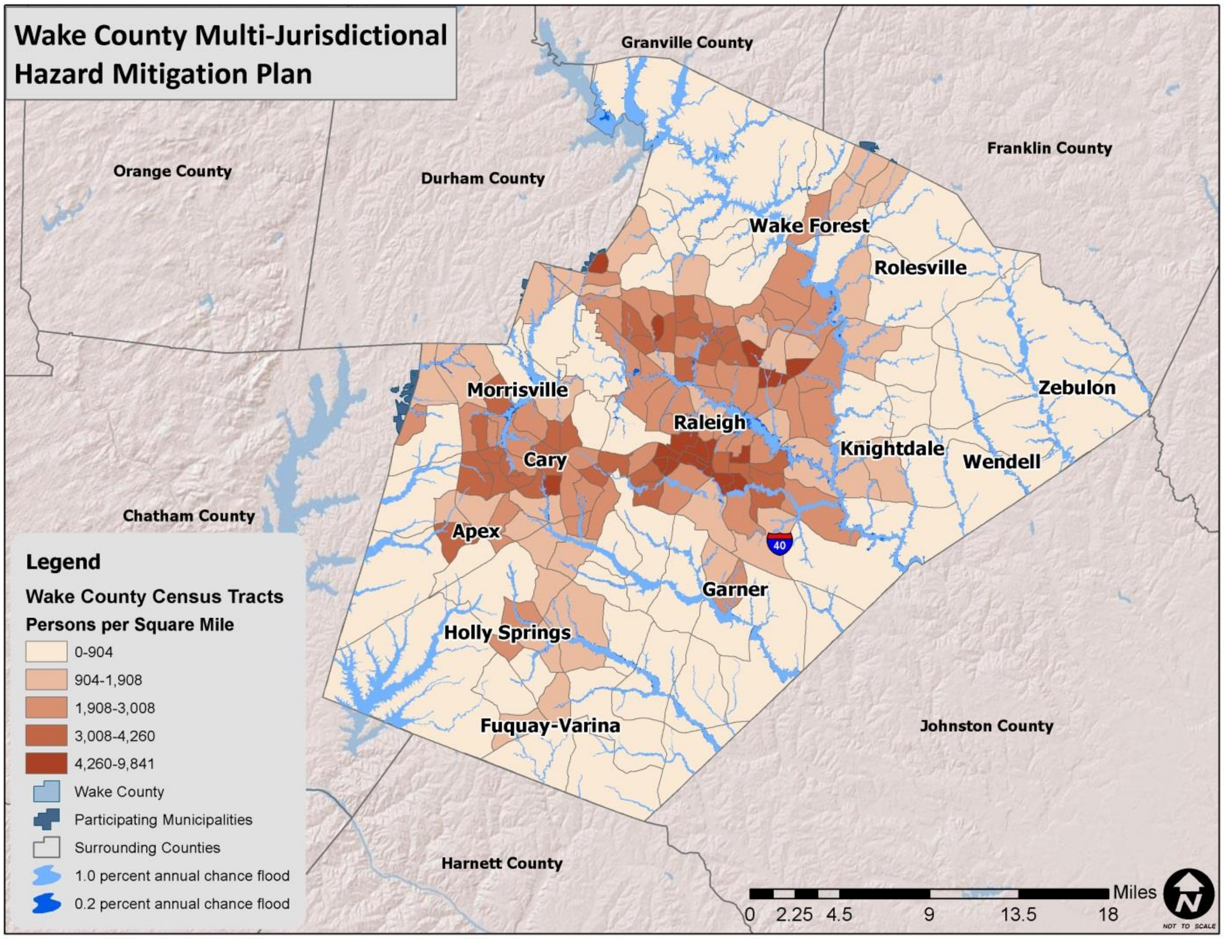
TABLE C.42: ESTIMATED EXPOSURE OF PARCELS TO THE FLOOD HAZARD

Location	1.0-percent ACF			0.2-percent ACF		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings
Fuquay-Varina	217	25	$42,721,538	44	20	$7,408,483

Source: FEMA DFIRM

Social Vulnerability
Since 2010 population was available at the tract level, it was difficult to determine a reliable figure on population at-risk to flood due to tract level population data. **Figure C.12** is presented to gain a better understanding of at risk population.

FIGURE C.12 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities

The critical facility analysis revealed that there are a no critical facilities located in the Fuquay-Varina 1.0-percent annual chance floodplain and 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. A list of specific critical facilities and their associated risk can be found in **Table C.48** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings and populations in Fuquay-Varina, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

Hazardous Materials Incident

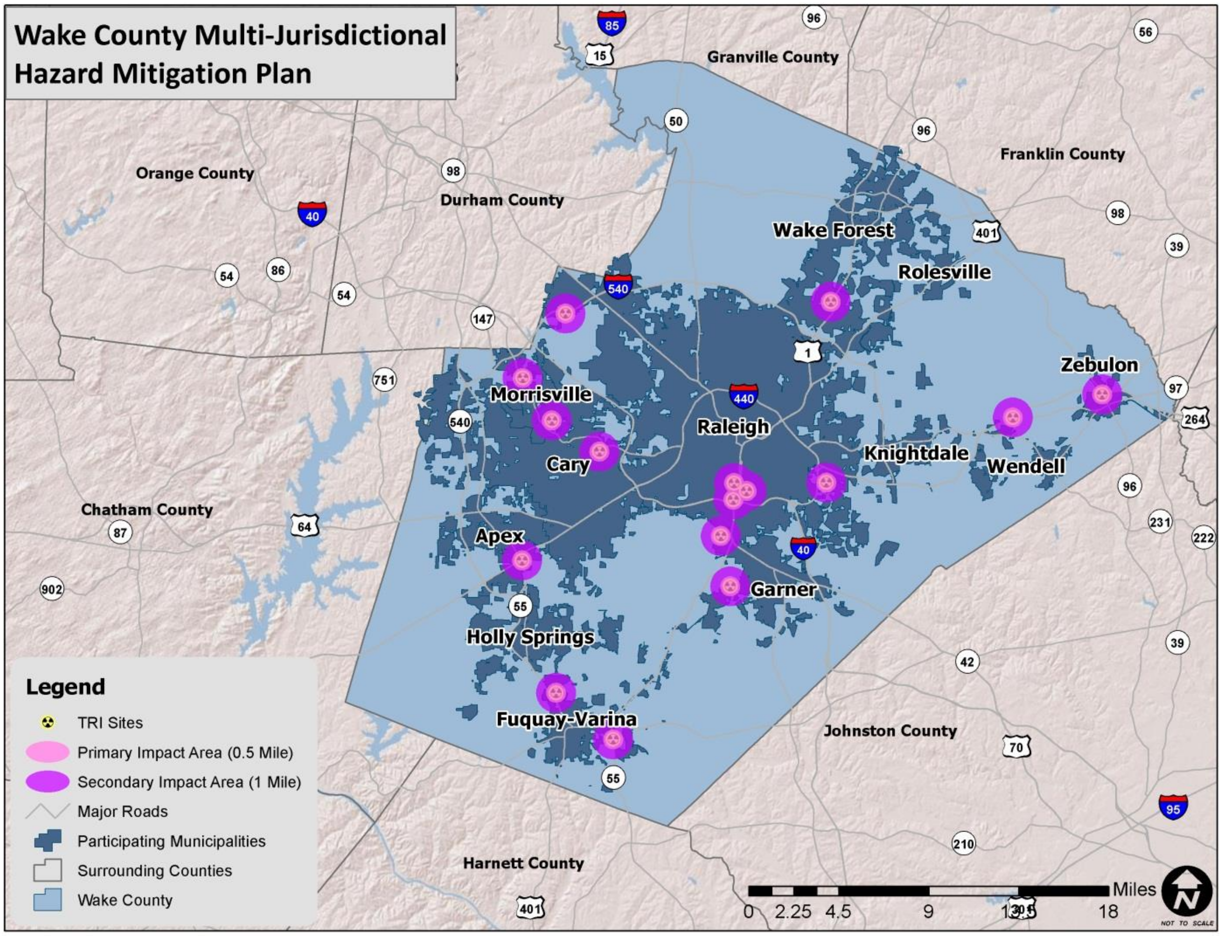
Although historical evidence and existing Toxic Release Inventory sites indicate that Fuquay-Varina is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Fuquay-Varina.

Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[19] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Fuquay-Varina, along with buffers, were used for analysis as shown in **Figure C.13.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the GIS buffer analysis. **Figure C.14** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table C.43** (fixed sites), **Table C.44** (mobile road sites) and **Table C.45** (mobile railroad sites).[20]

[19] This type of analysis will likely yield inflated results (generally higher than what is actually reported after an event).
[20] Note that parcels included in the 1.0-mile analysis are also included in the 0.5-mile analysis.

FIGURE C.13 : TRI SITES WITH BUFFERS IN FUQUAY-VARINA



Source: EPA

TABLE C.43: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Fuquay-Varina	562	476	$85,625,260	2,574	1,719	$428,181,023

FIGURE C.14 : MOBILE HAZMAT BUFFERS IN FUQUAY-VARINA

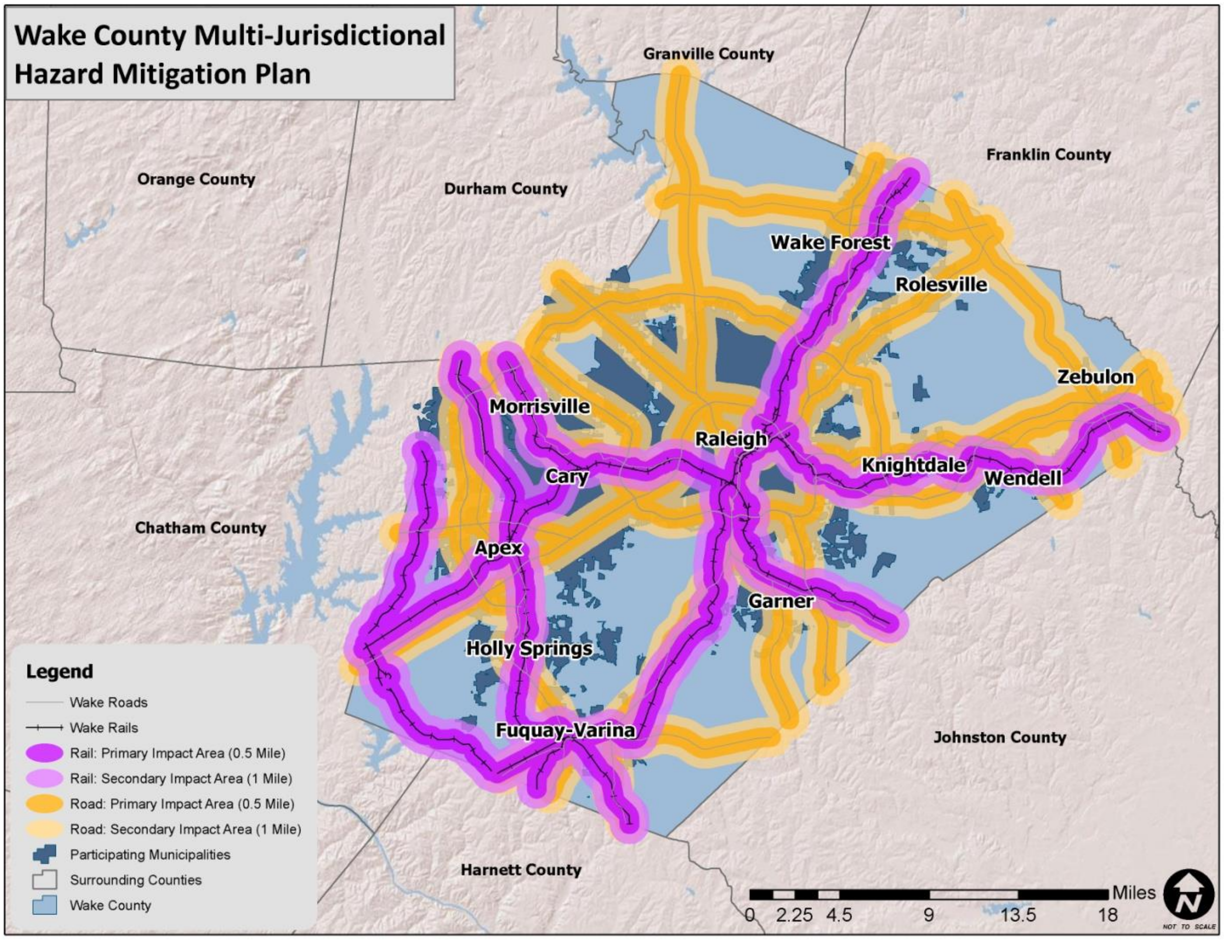


TABLE C.44: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Fuquay-Varina	6,025	4,876	$1,008,518,985	7,913	6,380	$1,342,413,178

TABLE C.45: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Fuquay-Varina	4,368	3,675	$804,969,402	7,279	5,941	$1,226,584,243

Social Vulnerability
Given high susceptibility across the jurisdiction, it is assumed that the total population is at risk to a hazardous materials incident. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities
Fixed Site Analysis:
The critical facility analysis for fixed TRI sites revealed that 1 critical facility is located in a HAZMAT risk zone. The facility is a school located in the primary impact zone. A list of specific critical facilities and their associated risk can be found in **Table C.48** at the end of this section.

Mobile Analysis:
The critical facility analysis for road and railroad transportation corridors in Fuquay-Varina revealed that there are 17 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 16 facilities. The remaining facility is located in the secondary, 1.0-mile zone. The railroad buffer areas also include 17 facilities with 16 in the primary impact zone. It should be noted that many of the facilities located in the buffer areas for railroad are also located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table C.48** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Fuquay-Varina. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc. Further, incidents from neighboring jurisdictions could also have an impact.

Wildfire
Although historical evidence indicates that Fuquay-Varina is susceptible to wildfire events, there are few reports of damage. Upon conversion of the wildfire risk data (see Section 6: *Vulnerability Assessment*) and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the jurisdiction should be assumed to be very low. As such, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the county.

Social Vulnerability
All areas have relatively equal vulnerability and there is low susceptibility across the entire county.
It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities
The critical facility analysis revealed that there are no critical facilities located in wildfire areas of concern. It should be noted, however, that several factors could impact the spread of a wildfire putting all facilities at risk. A list of specific critical facilities and their associated risk can be found in **Table C.48** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Fuquay-Varina.

Nuclear Accident

The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table C.46** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE C.46: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[21]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[22]
Fuquay-Varina	5,706	4,613	$872,156,725	8,830	7,048	$1,500,117,328

Social Vulnerability

Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities

The critical facility analysis revealed that there are a total of eighteen critical facilities located in the 10-mile nuclear buffer area including 1 EMS station, 1 fire station, 1 medical care facility, 4 schools, and 1 other in Fuquay-Varina.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in Fuquay-Varina, though areas closer to the power plant are at a higher risk than others. All structures are at some risk given that they are all located within at least the 50-mile buffer area.

Conclusions on Hazard Vulnerability

Table C.47 presents a summary of annualized loss for each hazard in Fuquay-Varina. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, although an annualized loss was determined

[21] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.

[22] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

through the damage reported through historical occurrences at the municipal level, it is likely that the county-wide estimate (found in Section 6: *Vulnerability Assessment*) is potentially a better estimate. These values should be used as an additional planning tool or measure risk for determining hazard mitigation strategies.

TABLE C.47: ANNUALIZED LOSS FOR FUQUAY-VARINA*

Event	Fuquay-Varina
Dam Failure	Negligible
Drought	Negligible
Erosion	Negligible
Extreme Heat	Negligible
Hail	Negligible
Hurricane & Tropical Storm	Negligible
Landslide	Negligible
Lightning	Negligible
Thunderstorm Wind/High Wind[23]	$25,950
Tornado	Negligible
Winter Storm & Freeze	Negligible
Flood	Negligible
Earthquake	Negligible
HAZMAT Incident	Negligible
Wildfire	Negligible
Nuclear Accident	Negligible
Terror Threat	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table C.48** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

[23] The annualized losses for these hazards were combined.

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TABLE C.48: AT-RISK CRITICAL FACILITIES IN FUQUAY-VARINA

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
FUQUAY-VARINA																								
FUQUAY	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
FUQUAY-VARINA #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
SOUTHERN WAKE- WAKEMED	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
TERRIBLE CREEK WWTP	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
BRIGHTON FOREST WWTP	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WINDSOR POINT ASSISTED LIVING	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
FUQUAY-VARINA HOMES FOR THE ELDERLY	OTHER	X	X	X	X	X	X	X	X	X							X	X		X		X	X	X
CARILLON ASSISTED LIVING	OTHER	X	X	X	X	X	X	X	X	X							X	X		X			X	X
UNIVERSAL HEALTHCARE	OTHER	X	X	X	X	X	X	X	X	X								X	X	X			X	X
FUQUAY-VARINA	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
FUQUAY-VARINA MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
LINCOLN HEIGHTS ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
BALLENTINE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
FUQUAY-VARINA ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
FUQUAY-VARINA HS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
WILLOW SPRINGS ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
BANKS ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
HERBERT AKINS ES	SCHOOL	X	X	X	X	X	X	X	X	X					X	X		X				X	X	X

Secondary Critical Facilities are listed in slight contrast to Critical Facilities as their continued function has not been deemed as critical as primary facilities in the event of a disaster, but these facilities are extremely important. A loss of function to one of these facilities would have a definitively greater negative impact on the community's ability to respond to and recover from a disaster than a loss of function at other facilities/structures within the jurisdiction. In **Table C.49**, these facilities have been classified as either Significant Community Locations/Sheltering Centers or as Critical Resources Management Facilities. These facilities are all vulnerable to any of the atmospheric hazards and many are also likely vulnerable to other hazards identified above, though no locational analysis was carried out to this end.

TABLE C.49: FUQUAY-VARINA SECONDARY CRITICAL FACILITIES

Facility Name	Address*	Type
Fuquay-Varina		
Town Hall	401 Old Honeycutt Rd.	Significant Community Location or Sheltering Center
Water Pressure Booster Stations	3 locations	Critical Resources Management (Energy, Water, etc.)
Sewer Lift Stations	23 locations	Critical Resources Management (Energy, Water, etc.)
Water Tower	304 Jones Lane	Critical Resources Management (Energy, Water, etc.)
Water Tower	N. Main St	Critical Resources Management (Energy, Water, etc.)
Duke Energy CPL Substations	• Holland Rd (230KV) • Fleming Rd (230KV) • Dickens Rd (115KV)	Critical Resources Management (Energy, Water, etc.)
Public Works Facility		Critical Resources Management (Energy, Water, etc.)
Southern Regional Government Center		Significant Community Location or Sheltering Center
South Park Community Center		Significant Community Location or Sheltering Center
Council Gym		Significant Community Location or Sheltering Center
Johnson House		Historic Location
Wake County Public Library		Significant Community Location or Sheltering Center
Hilltop Christian School	Inside Hilltop Church	Significant Community Location or Sheltering Center
Southern Wake Academy		Significant Community Location or Sheltering Center

**Some address information could not be provided or was not applicable to the facility*

C.4 TOWN OF FUQUAY-VARINA CAPABILITY ASSESSMENT

This subsection discusses the capability of the Town of Fuquay-Varina to implement hazard mitigation activities. More information on the purpose and methodology used to conduct the assessment can be found in Section 7: *Capability Assessment*.

C.4.1 Planning and Regulatory Capability

Table C.50 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the Town of Fuquay-Varina. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE C.50: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning Tool/Regulatory Tool	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan (Parks & Rec/Greenway Plan	Stormwater Management Plan/Ordinance	Natural Resource Protection Plan	Flood Response Plan	Emergency Operations Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	National Flood Insurance Program (NFIP)	NFIP Community Rating System
Fuquay-Varina	✓	✓		✓	*		✓	✓				✓	✓		✓	✓	✓	*		✓	✓	✓	

A more detailed discussion on the town's planning and regulatory capabilities follows.

Emergency Management

Hazard Mitigation Plan
The Town of Fuquay-Varina has previously adopted a hazard mitigation plan.

Emergency Operations Plan
The Town of Fuquay-Varina has adopted the Wake County Emergency Operations Plan. The town also maintains a municipal-level emergency operations plan.

Flood Response Plan
The Town of Fuquay-Varina has adopted a Flood Response Plan for secondary roads and town streets that are prone to flood in certain storm events.

General Planning

Comprehensive Land Use Plan
The Town of Fuquay-Varina has adopted a land use plan as well as a comprehensive growth management plan.

Capital Improvements Plan
The Town of Fuquay-Varina has a five-year capital improvement plan in place.

Zoning Ordinance
The Town of Fuquay-Varina has adopted a zoning ordinance and is in the process of developing a local unified development ordinance.

Subdivision Ordinance
The Town of Fuquay-Varina has adopted a subdivision ordinance and is in the process of developing a local unified development ordinance.

Building Codes, Permitting, and Inspections
North Carolina has a state compulsory building code which applies throughout the state. The building code is enforced within the town's planning jurisdiction by the Town of Fuquay-Varina Building Inspections Department.

Floodplain Management

Table C.51 provides NFIP policy and claim information for the Town of Fuquay-Varina.

TABLE C.51: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
Fuquay-Varina	11/01/78	04/16/07	85	$20,597,500	1	$5,783

Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Flood Damage Prevention Ordinance
All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. The Town of Fuquay-Varina participates in the NFIP and has adopted flood damage prevention regulations.

Open Space Management Plan
The Town of Fuquay-Varina has adopted an open space plan, a greenways system master plan, as well as a parks, recreational, and cultural resources master plan.

Stormwater Management Plan
The Town of Fuquay-Varina has not adopted a stormwater management plan; however, the town has adopted a stormwater management ordinance.

C.4.2 Administrative and Technical Capability

Table C.52 provides a summary of the capability assessment results for the Town of Fuquqy-Varina with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in the town with the specified knowledge or skill.

TABLE C.52: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	Planners with knowledge of land development/land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency Manager	Floodplain Manager	Land Surveyors	Scientists familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Resource development staff or grant writers
Fuquay-Varina	✓	✓	✓	✓	✓		✓	✓	✓	

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

C.4.3 Fiscal Capability

Table C.53 provides a summary of the results for the Town of Fuqua-Varina with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plan.

TABLE C.53: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes (or taxing districts)	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.
Fuquay-Varina	✓	✓	✓						✓	✓

C.4.4 Political Capability

The previous hazard mitigation plan indicates that the Fuquay-Varina Board of Commissioners supports the need for hazard mitigation to reduce future losses of life and property and will support hazard mitigation efforts, while acknowledging the realistic resources both monetarily and physically at the Town's disposal. The Town citizens, property owners, business owners, and elected officials and staff are fully aware of the potential threats to life and property. As all these parties continue to strive to make Fuquay-Varina a safer community, implementation of the hazard mitigation plan will be seen as another means to help achieve that goal.

C.4.5 Conclusions on Local Capability

Table C.54 shows the results of the capability assessment using the designed scoring methodology described in Section 7: *Capability Assessment*. The capability score is based solely on the information found in existing hazard mitigation plan and readily available on the town's government website. According to the assessment, the local capability score for the town is 43, which falls into the high capability ranking.

TABLE C.54: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
Fuquay-Varina	43	HIgh

C.5 TOWN OF FUQUAY-VARINA MITIGATION STRATEGY

This subsection provides the blueprint for Fuquay-Varina to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Regional Work Groups and the findings and conclusions of the capability assessment and risk assessment. Additional Information can be found in Section 8: *Mitigation Strategy* and Section 9: *Mitigation Action Plan*.

C.5.1 Mitigation Goals

Fuquay-Varina developed seven mitigation goals in coordination with Wake County and the other participating municipalities. The county-wide mitigation goals are presented in **Table C.55**.

TABLE C.55: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

C.5.2 Mitigation Action Plan

The mitigation actions proposed by Fuquay-Varina are listed in the following Mitigation Action Plan.

Town of Fuquay-Varina Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Update the Land Use Plan (LUP) update including identification of environmentally sensitive areas for evaluation and protection during development review process.	All, Flood	Moderate	Fuquay-Varina Planning	Local	December 2015 - 2016	The Town will work toward a cycle of LUP area updates within the period of this HMP. The last officially adopted update was in 2005. Lack of staffing and budget constraints have prevented update further than minor updates related to zoning changes.
P-2	Enforce 50' riparian stream buffers in Neuse and Cape Fear River basins to restrict development in these protected areas.	Flood	High	Fuquay-Varina Planning	Local	Completed	The Town's riparian buffer requirements in Cape Fear River Basin are additional to those required by the State for only the Neuse River Basin. Requirements enforced through new development applications since adoption in 2006.This action will be removed from the plan at the next update.
P-3	Update the Community Transportation Plan including evaluation of stream-crossings to reduce impacts on streams, flood plains and wetlands.	Flood	Moderate	Fuquay-Varina Planning	Local	December 2015	Update existing plan, adopted in 2007, to reflect changes and new developments in facilities, transportation, infrastructure, and environmental features. Overall update of the CTP is tied to the Southwest Area Study (SWAS) which was delayed for over 2 years, with adoption postponed until mid-2014.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-4	Update land Development Ordinance (LDO) to incentivize and encourage floodplains, wetlands, riparian buffers to be maintained as open space.	Flood	Moderate	Fuquay-Varina Planning and Engineering	Local	June 2015	In progress. Adoption of LDO is anticipated in June 2015, with efforts referenced to be in addition to current standards. Town Board decision on process and approval to proceed with development of the LDO delayed ability to begin.
P-5	Add standards to LDO to reduce impervious surface areas as part of landscaping requirements to reduce storm water volume and concentration in nonresidential development.	Flood	Moderate	Fuquay-Varina Planning and Engineering	Local	June 2015	In progress. Adoption of LDO is anticipated in June 2015, with efforts referenced to be in addition to current standards that will minimize impervious surface and utilize alternative construction materials to reduce runoff and impact on water courses. Action hinges on LDO.
P-6	Develop Stormwater Management Plan based on NPDES Phase II Stormwater Requirements.	Flood	High	Fuquay-Varina Engineering	Local	February 2014	Completed. Adoption of Stormwater Management Plan in February 2014 to assist in regulation of runoff control and reduced effects of hazards.
P-7	Require pre and post construction certification for residential lot development within 10 feet of Wake County Flood Hazard Soils.	Flood	Moderate	Fuquay-Varina Planning	Local	Completed	Completed. The Town requires this information with building permit for single family homes in residential developments to provide that new structures are not encroaching into environmentally sensitive areas. This action will be removed from the plan at the next update.
P-8	Enforce Wake County Flood Hazard Soils Policy, following and utilizing flood study standards.	Flood	Moderate	Fuquay-Varina Planning	Local	2015	New action. The Town enforces an adopted policy related to protection of Wake County Flood Hazard Soils.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-9	Annually calculate acreage of flood prone property preserved as open space.	Flood	Moderate	Fuquay-Varina Planning	Local	2015, Annual review and update	The Town continues to see development of subdivisions utilizing open space and thereby preserving flood prone areas. The Town is also working to connect park facilities to minimize disturbance of land, and provide connections to schools via cooperation with Wake County Board of Education.
P-10	Adopt a Land Development Ordinance that will improve the review process, standards and results to reduce the impact of development on the natural environment.	Flood	Moderate	Fuquay-Varina Planning	Local	June 2015	In progress. Anticipated adoption of LDO is June 2015. See action related to adoption of LDO.
P-11	Implement standard for each buildable lot to have a minimum percentage of buildable area outside floodplains, wetlands, riparian buffers as part of the plan review and recording process.	Flood	High	Fuquay-Varina Planning	Local	June 2015	In progress. Adoption of LDO is anticipated in June 2015, with efforts referenced to be in addition to current standards. This strategy will provide for a minimum buildable area outside of any environmentally sensitive areas that may be present. See action related to adoption of LDO.
P-12	Map storm water drainage system as part of Phase II Stormwater Management Plan.	Flood	High	Fuquay-Varina Engineering	Local	2015, Annual review and update	The Town continues to map both existing and new systems in order to provide more accurate account of facilities.
P-13	Provide for public dissemination building inspections brochures regarding high winds, water damage prevention, and tie downs for accessory structures.	Flood, Tornado, Hurricane, Thunderstorm/ High Wind	Moderate	Fuquay-Varina Inspections	Local	2015, Annual review and update	Brochures are available in public location at the Town Hall and are regularly distributed. Enforcement of the NC Building Code also furthers this effort.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Property Protection							
PP-1	Continue to enforce the Flood Damage Prevention Ordinance for all new construction or substantial building rehabilitations.	Flood	High	Fuquay-Varina Planning	Local	Completed	The review process for new development and rehab or expansion of existing development requires permittees to address any environmentally sensitive areas via the permitting process. This action will be removed from the plan at the next update.
PP-2	Require minimum finished floor elevation in known FEMA flood hazard zones be minimum 2' about base flood elevation.	Flood	High	Fuquay-Varina Planning and Inspections	Local	Completed	Enforced through building permitting and verification between departments. See PP-1 implementation status above. This action will be removed from the plan at the next update.
PP-3	Develop Stormwater Management Plan based on NPDES Phase II Stormwater Requirements to help reduce flood damages (see also P-6).	Flood	High	Fuquay-Varina Engineering	Local	Completed	Completed. Adoption of Stormwater Management Plan in February 2014 to assist in regulation of runoff control and reduced effects of hazards.
PP-4	Identify and inventory buildings that are located in FEMA flood zones to determine which structures may be prone to flooding (possible relocation and/or elevation).	Flood	High	Fuquay-Varina Planning and Engineering	Local	December 2014	In progress. Inventory to be compiled using LIDAR data recently made available, along with 2006 FEMA FIRM mapping.
Natural Resource Protection							
NRP-1	Work with the U.S. Army Corps of Engineers on wetland protection.	Flood	Moderate	Fuquay-Varina Planning	Local	2015, Annual review and update	Annual effort to minimize the impact on environmentally sensitive areas and is integral to procedures outlined in the Town's regulations.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-2	Use Open Space Ordinance to protect wildlife habitat.	All	Moderate	Fuquay-Varina Planning	Local	Completed	The open space development regulations, most commonly used residential development use in town, provide that no environmentally sensitive areas be lotted into and remain as open space. This regulation provides protection from disturbance. This action will be removed from the plan at the next update.
NRP-3	Continue to utilize Wake County Erosion and Sedimentation Control to ensure proper erosion control procedures are followed before and during construction.	Flood, Erosion	Moderate	Fuquay-Varina Planning and Inspections	Local	Completed	The Town has an ongoing relationship with Wake County Erosion Control, who is contracted to provide services listed. There is procedure to ensure that projects don't move forward to construction from plan review without being reviewed by WCEC. This action will be removed from the plan at the next update.
NRP-4	Notify Wake County of any illegal stream dumping instances	Flood	Moderate	Fuquay-Varina Public Utilities, Wake County Environmental Services	Local	Completed	The Town continues to work with Wake County on illegal dumping to maintain free flow in water ways and reduce runoff and impacts to downstream structures. This action will be removed from the plan at the next update.
NRP-5	Incorporate regulations for illicit discharge control in Phase II Stormwater Management Plan.	Flood	Moderate	Fuquay-Varina Engineering	Local	February 2014	Completed. Adoption of Stormwater Management Plan in February2014 to assist in regulation of runoff control and reduced effects of hazards.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-6	Enforce standards for tree protection and control of clear cutting (Town has received legislative authority to enact tree protection and control of clear cutting standards.)	Flood	High	Fuquay-Varina Planning	Local	Completed	The Town's program has been in place since 2007 and is a standard used with new developments to minimize erosion and maintain vegetative areas. This action will be removed from the plan at the next update.
Structural Projects							
SP-1	Incorporate on-site retention/detention requirements for Phase II Stormwater Management Plan.	Flood	High	Fuquay-Varina Engineering	Local	Completed	Completed. Adoption of Stormwater Management Plan in February 2014 to assist in regulation of runoff control and reduced effects of hazards.
Emergency Services							
ES-1	Maintain current warning system with local sirens on elevated platforms and use of the Emergency Broadcast System.	All	High	Fuquay-Varina Fire, Police, and Wake County Emergency Management	Local, County, State	Completed	Land officials work with County and others in order to ensure proper maintenance of equipment. This action will be removed from the plan at the next update.
ES-2	Examine need to evaluate weather radio distribution program (daycares/nursing homes) initiated by Wake County Emergency Management 1999	All	Moderate	Wake County Emergency Management	County	2015, Annual review and update	This strategy is annually updated, as the need is subject to change over time, but has not yet been determined to be such a need that implementation is necessary.
ES-3	Revise current (1977) Town ordinance regarding civil preparedness	All	Moderate	Fuquay-Varina Fire and Police	Local	Completed	Completed. In 2006, the Town adopted a new Emergency Operations Plan and Disaster Operations Plan with funding though WCEM, with the plan mirroring the Wake County plan with the exception of personnel and responsibilities.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-4	Update and implement a Basic Emergency Operations Plan and a Disaster Operations Plan for the Town.	All	Moderate	Fuquay-Varina Fire and Police	Local	June 2016	Update necessary aspects of plans, adopted in 2006, for relevance, personnel, and responsibilities.
ES-5	Coordinate an incident command course for all Town employees, related to Emergency Operations Plan and Disaster Operations Plan for the Town.	All	Moderate	Fuquay-Varina Fire and Police	Local	November 2016	New action. Provide training on general and updated plans to be better prepared for implementation if necessary.
ES-6	Conduct a scenario-based training exercise, related to Emergency Operations Plan and Disaster Operations Plan for the Town.	All	Moderate	Fuquay-Varina Fire and Police	Local	March 2017	New action. Conduct a training exercise to further objective of training and preparedness for employees.
ES-7	Assist Wake County Emergency Management with updating list of local hazardous materials sites.	All	Moderate	Fuquay-Varina Fire and Wake County Emergency Management	Local, County	Completed	Town departments work regularly and closely with WCEM to ensure coordination on known hazardous sites. Facilities are reviewed and inspected, with Fire Department involved in plan review prior to development. This action will be removed from the plan at the next update.
ES-8	Continue Pre-Fire Incident Plan program for all commercial facilities within the Town limits.	All	High	Fuquay-Varina Fire	Local	Completed	nspections of commercial facilities occur at regular intervals in an effort to ensure maintenance and consistency with initial approval. Fire hazards are thereby reduced. This action will be removed from the plan at the next update.
ES-9	Address securing and cleaning up affected hazardous areas when revising Disaster Operations Plan.	All	High	Fuquay-Varina Fire and Police, Wake County Emergency Management and North Carolina Highway Patrol	Local, County	Completed	Completed. This item has been implemented as referenced, but may also be updated in accordance with updates to Emergency Management Plan, as referenced in action item above.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-10	Continue to evaluate and improve response and recovery methods following each hazard event.	All	High	Fuquay-Varina Fire and Police	Local	Completed	This is an ongoing process to improve and evaluate responses and recovery methods for hazard events. Training and post evaluation help improve capabilities. This action will be removed from the plan at the next update.
ES-11	Examine the feasibility and need to contract/purchase a reverse 911 system to alert citizens of impending danger.	All	Moderate	Fuquay-Varina Fire, Police, Information Technology and Public Information	Local	June 2016	In progress. The idea of a reverse system must be vetted for feasibility and cost-benefit of implementation to minimize possible loss of life.
ES-12	Finalize implementation of new/updated radio communication equipment.	All	Moderate	Fuquay-Varina Fire and Police	Local	January 2017	New action. Beginning in 2013, radio communication equipment replacement is currently occurring, with completion anticipated in January 2017.
Public Education and Awareness							
PEA-1	Maintain floodplain maps for public use and produce other maps as needed.	Flood	Moderate	Fuquay-Varina Planning and Engineering	Local	2015, Quarterly review and update	The Town maintains a website with up-to-date flood mapping. The Town provides printed maps as requested and updates maps for public display approximately quarterly. Other maps, such as transportation or land use maps, include environmental information to help support protection.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-2	Develop and maintain a hazard mitigation section on the Town website that is updated every 5 years as the plan is updated.	All	High	Fuquay-Varina Planning and Information Technology	Local	Completed	The Town's webpage dedicated to the HMP is user-friendly and easy to understand for the general public, and is regularly reviewed for relevant content and updated as appropriate. This action will be removed from the plan at the next update.
PEA-3	Collect educational materials on disaster preparedness and display at public library and local government offices.	All	High	Fuquay-Varina Planning, Inspections, Police, and Fire	Local	Completed	The Town makes available brochures and materials at a public location in Town Hall for anyone interested. The plan was provided to the local public library in 2004 and since. This action will be removed from the plan at the next update.
PEA-4	Educate public on importance of channel maintenance as part of Phase II Stormwater Management Plan.	Flood	Moderate	Fuquay-Varina Engineering	Local	Completed	In previous years through 2014, the Town has partnered with the Clean Water Education Partnership for material dissemination at events. This action will be removed from the plan at the next update.
PEA-5	Work with local real estate agents to ensure that potential buyers are aware of properties that are exposed to potential flood damage.	Flood	Moderate	Fuquay-Varina Planning	Local	Completed	Staff works with agents regarding any questions they propose. The same sources of information references in PEA-1 above are available for use. This action will be removed from the plan at the next update.
PEA-6	Require delineation of Wake County Flood Hazard Soils, FEMA flood zones, and wetlands on final plats.	Flood	Moderate	Fuquay-Varina Planning	Local	Completed	The Town makes every effort to include information on final subdivision plats. This action will be removed from the plan at the next update.

Annex D
Town of Garner

This annex includes jurisdiction-specific information for the Town of Garner. It consists of the following five subsections:

- D.1 Town of Garner Community Profile
- D.2 Town of Garner Risk Assessment
- D.3 Town of Garner Vulnerability Assessment
- D.4 Town of Garner Capability Assessment
- D.5 Town of Garner Mitigation Strategy

D.1 TOWN OF GARNER COMMUNITY PROFILE

D.1.1 Geography and the Environment

Garner is town located in Wake County in the state of North Carolina. It was incorporated in 1905 but experienced growth initially after it was established as a railroad station, called Garner's Station, in 1883.

Overall, Wake County is known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Summer temperatures generally venture into the 90s for highs and cool off to the 70s at night. Winter temperatures in can drop to below freezing but generally highs are in the 50s. Rainfall is most common in the summer months but occurs consistently throughout the year.

D.1.2 Population and Demographics

According to the 2010 Census, Garner has a population of 25,745 people. The jurisdiction has seen exceptional growth between 2000 and 2010, and the population density is over 1,700 people per square mile. Population counts from the US Census Bureau for 1990, 2000, and 2010 are presented in **Table D.1**.

TABLE D.1: POPULATION COUNTS FOR GARNER

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
GARNER	14,967	17,575	25,745	46.49%

Source: US Census Bureau

The racial characteristics of the jurisdiction are presented in **Table D.2**. Whites make up the majority of the population in the jurisdiction, accounting for just over 50% percent of the population.

TABLE D.2: DEMOGRAPHICS OF GARNER

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
GARNER	57.8%	32.9%	0.5%	8.8%	9.3%

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

D.1.3 Housing

According to the 2010 US Census, there are 10,993 housing units in Garner, the majority of which are single family homes or mobile homes. Housing information for the jurisdiction is presented in **Table D.3**.

TABLE D.3: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Seasonal Units, Percent (2010)	Median Home Value (2006-2010)
GARNER	7,252	10,993	7.2%	$168,300

Source: US Census Bureau

D.1.4 Infrastructure

Transportation

There are several major roadways that residents of Garner utilize. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs, one of which is I-540/NC-540 which is a partly completed loop that connects the jurisdiction to many of the other municipalities. In addition to the Interstate, there are many major highways that residents of the municipality utilize. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways in the include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities

Electrical power in the jurisdiction is provided by two entities and Duke Energy and Wake Electric Membership Corporation with Duke Energy providing service to a majority of the service. Water and sewer service is provided by two main entities as well: The City of Raleigh Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

Community Facilities

There are a number of buildings and community facilities located throughout Garner. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 3 fire stations, 5 police stations, and 9 public schools located within the jurisdiction.

Citizens also have access to several parks, including three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the county, including the American Tobacco Trail which is a rails to trails project that is open to a wide variety of non-motorized uses.

D.1.5 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land as parks. There are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the jurisdiction consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

D.1.6 Employment and Industry

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

D.2 TOWN OF GARNER RISK ASSESSMENT

This subsection includes hazard profiles for each of the significant hazards identified in Section 4: *Hazard Identification* as they pertain to Garner. Each hazard profile includes a description of the hazard's location and extent, notable historical occurrences, and the probability of future occurrences. Additional information can be found in Section 5: *Hazard Profiles*.

D.2.1 Drought

Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, Garner has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that the county would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Historical Occurrences

According to the North Carolina Drought Monitor, Garner has had drought occurrences all of the last fourteen years (2000-2013). **Table D.4** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE D.4: HISTORICAL DROUGHT OCCURRENCES IN GARNER

Abnormally Dry | Moderate Drought | Severe Drought | Extreme Drought | Exceptional Drought

	Garner
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that Garner has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

D.2.2 Extreme Heat

Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to any geographic or political boundaries. All of Garner is susceptible to extreme heat conditions.

Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Garner. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the region. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the county. The most centralized location is in Raleigh at North Carolina State University. **Table D.5** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table D.5: Average Maximum Temperature in Raleigh, Wake County

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

D.2.3 Hailstorm

Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Garner is uniformly exposed to severe thunderstorms; therefore, all areas are equally exposed to hail which may be produced by such storms.

Historical Occurrences

According to the National Climatic Data Center, 13 recorded hailstorm events have affected Garner since 1993.[1] **Table D.6** is a summary of the hail events in Garner. **Table D.7** provides detailed information about each event that occurred. In all, hail occurrences resulted in over $0 (2013 dollars) in property damages. Hail ranged in diameter from 0.75 inches to 1.75 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value.

Table D.6: Summary of Hail Occurrences in Garner

Location	Number of Occurrences	Property Damage (2013)
Garner	13	$0

Source: National Climatic Data Center

[1] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Garner. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

TABLE D.7: HISTORICAL HAIL OCCURRENCES IN GARNER

	Date	Magnitude	Deaths/Injuries	Property Damage*
Garner				
Nr Garner	7/10/1995	0.75 in.	0/0	$0
GARNER	3/20/1998	0.75 in.	0/0	$0
GARNER	5/26/1998	0.75 in.	0/0	$0
GARNER	6/3/2000	1.75 in.	0/0	$0
GARNER	6/14/2000	1 in.	0/0	$0
GARNER	5/19/2004	1 in.	0/0	$0
GARNER	6/7/2005	1 in.	0/0	$0
GARNER	4/3/2006	1.75 in.	0/0	$0
GARNER	5/14/2006	0.75 in.	0/0	$0
GARNER	5/14/2006	1 in.	0/0	$0
GARNER	5/14/2006	1.75 in.	0/0	$0
GARNER	5/14/2006	0.88 in.	0/0	$0
GARNER	5/14/2006	1.75 in.	0/0	$0
GARNER	5/20/2006	0.75 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that Garner has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the county.

D.2.4 Hurricane and Tropical Storm

Location and Spatial Extent

Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Garner. The entire jurisdiction is equally susceptible to hurricane and tropical storms.

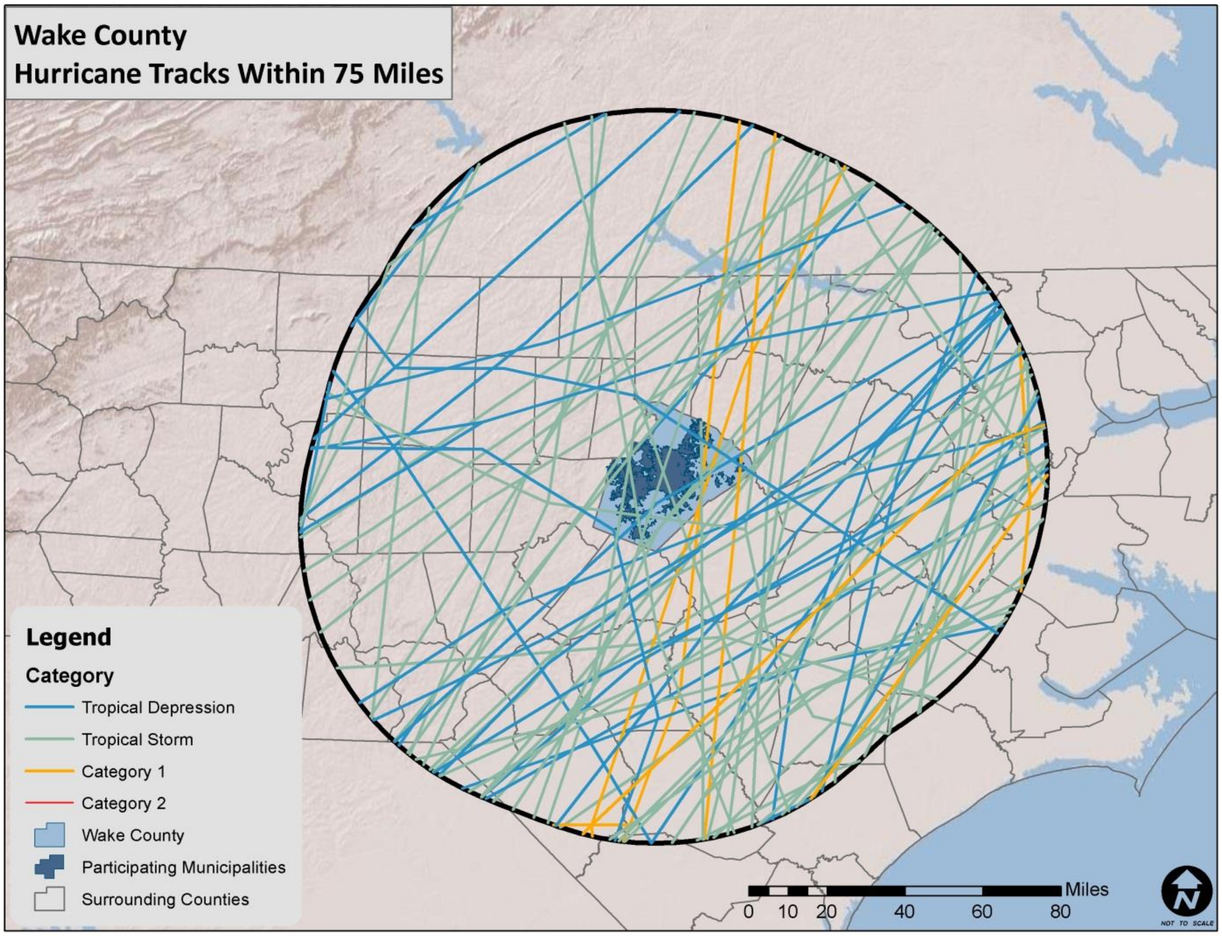
Historical Occurrences

According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[2] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms have traversed directly through Wake County as shown in **Figure D.1**. **Table D.8** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

[2] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

FIGURE D.1: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE D.8: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1
1882	NOT NAMED	53	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm
1959	CINDY	26	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression
2008	HANNA	40	Tropical Storm

Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Garner between 1950 and 2013. These storms are listed in **Table D.9** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE D.9: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made in 1996 (Hurricane Fran), 1999 (Hurricane Floyd), and 2003 (Hurricane Isabel) for the county.[3]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Tropical Storm Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

Probability of Future Occurrences
Given the inland location of the jurisdiction, it is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Garner. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the jurisdiction is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

[3] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

D.2.5 Lightning

Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Garner is uniformly exposed to lightning.

Historical Occurrences

According to the National Climatic Data Center, there have been no recorded lightning events in Garner since 1950, as listed in summary **Table D.10** and detailed in **Table D.11**.[4] However, it is certain that lightning events have in fact impacted the jurisdiction. Many of the reported events are those that caused damage, and it should be expected that damages are likely much higher for this hazard than what is reported.

TABLE D.10: SUMMARY OF LIGHTNING OCCURRENCES IN GARNER

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Garner	0	0/0	$0

Source: National Climatic Data Center

TABLE D.11: HISTORICAL LIGHTNING OCCURRENCES IN GARNER

	Date	Deaths/Injuries	Property Damage*	Details
Garner				
None reported				

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Although there were not a high number of historical lightning events reported in Garner via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S. National Lightning Detection Network (NLDN®), Garner is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the jurisdiction.

D.2.6 Severe Thunderstorm/High Wind

Location and Spatial Extent

A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Garner. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

favorable for generating these powerful storms. Also, Garner typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Garner has uniform exposure to an event and the spatial extent of an impact could be large.

Historical Occurrences

Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011.[5] According to NCDC, there have been 11 reported thunderstorm/high wind events since 1994 for high wind and since 1950 for thunderstorms.[6] These events caused over $0 (2013 dollars) in damages. **Table D.12** summarizes this information. **Table D.13** presents detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event.[7]

TABLE D. 12: SUMMARY OF THUNDERSTORM/HIGH WIND OCCURRENCES IN GARNER

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Garner	11	0/0	$0

Source: National Climatic Data Center

TABLE D.13: HISTORICAL THUNDERSTORM/HIGH WIND OCCURRENCES IN GARNER

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Garner					
GARNER	3/3/1999	TSTM WIND	50 kts.	0/0	$0
GARNER	7/12/2004	TSTM WIND	50 kts.	0/0	$0
GARNER	7/28/2005	TSTM WIND	52 kts.	0/0	$0
GARNER	4/17/2006	TSTM WIND	50 kts.	0/0	$0
GARNER	4/25/2006	TSTM WIND	54 kts.	0/0	$0
GARNER	6/11/2006	TSTM WIND	56 kts.	0/0	$0
GARNER	7/29/2006	TSTM WIND	50 kts.	0/0	$0
GARNER	4/15/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
GARNER	8/21/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
GARNER	8/21/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
GARNER	5/9/2012	THUNDERSTORM WIND	50 kts.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

[5] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional thunderstorm events have occurred in Garner. As additional local data becomes available, this hazard profile will be amended.
[7] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

Probability of Future Occurrences

Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire jurisdiction.

D.2.7 Tornado

Location and Spatial Extent

Tornadoes occur throughout the state of North Carolina, and thus in Garner. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Garner is uniformly exposed to this hazard.

Historical Occurrences

Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there have been two recorded tornado events in Garner since 1956 (**Table D.14**), resulting in nearly $1.1 million (2013 dollars) in property damages.[8] There were also 2 injuries associated with tornadoes. Detailed information on these events can be found in **Table D.15**. The greatest magnitude of these tornadoes was a F2 in intensity, although an F5 event is possible. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is likely that a high number of occurrences have gone unreported over the past 50 years.

TABLE D.14: SUMMARY OF TORNADO OCCURRENCES IN GARNER

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Garner	2	0/2	$1,036,983

Source: National Climatic Data Center

TABLE D.15: HISTORICAL TORNADO IMPACTS IN GARNER

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Garner					
Garner	3/20/1998	F2	0/2	$1,036,983	The tornado remained a funnel as it roared over the Greenbrier Estates just east of US401. Trees were sporadically uprooted and snapped off. Several trees fell on homes and outbuildings. The tornado touched down on Highway 70 at a church. The roof of one section was taken off and the steeple was blown off the chapel. The debris from the church took out windows at a car lot across the street. A block way, the wind removed several large siding sheets

[8] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Garner. As additional local data becomes available, this hazard profile will be amended.

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
					from a business
Garner	9/14/2007	F0	0/0	$0	EVENT NARRATIVE: Public reported a brief touch down of a tornado with debris just south of Garner near Lake Benson.

*Property Damage is reported in 2013 dollars.
Source: NCDC

2011 Tornadoes- April 16, 2011
In 2011, the county and all of its jurisdictions were impacted by one of the worst tornado-related events in the county's recorded history. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries.

Probability of Future Occurrences
According to historical information, tornado events are not an annual occurrence for the jurisdiction. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Garner experience a direct tornado strike. The probability of future tornado occurrences affecting Garner is likely (10-100 percent annual probability).

D.2.8 Winter Storm and Freeze

Location and Spatial Extent
Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Garner is accustomed to smaller scale severe winter weather conditions and often receives severe winter weather during the winter months. Given the atmospheric nature of the hazard, the entire jurisdiction has uniform exposure to a winter storm.

Historical Occurrences
Severe winter weather has resulted in six disaster declarations in Garner. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. [9] According to the National Climatic Data Center, there have been no recorded winter storm events in Garner since 1993 (**Table D.16**).[10] These events resulted in $0 (2013 dollars) in damages. However, there have been 28 recorded countywide events and most severe winter weather events are only recorded at the county level.

[9] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[10] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional winter storm conditions have affected Garner.

TABLE D.16: SUMMARY OF WINTER STORM EVENTS IN GARNER

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Garner	0	0/0	$0

Source: National Climatic Data Center

There have been several severe winter weather events in Garner. The text below describes one of the major events and associated impacts on the county. Similar impacted can be expected with severe winter weather.

1996 Winter Storm
This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

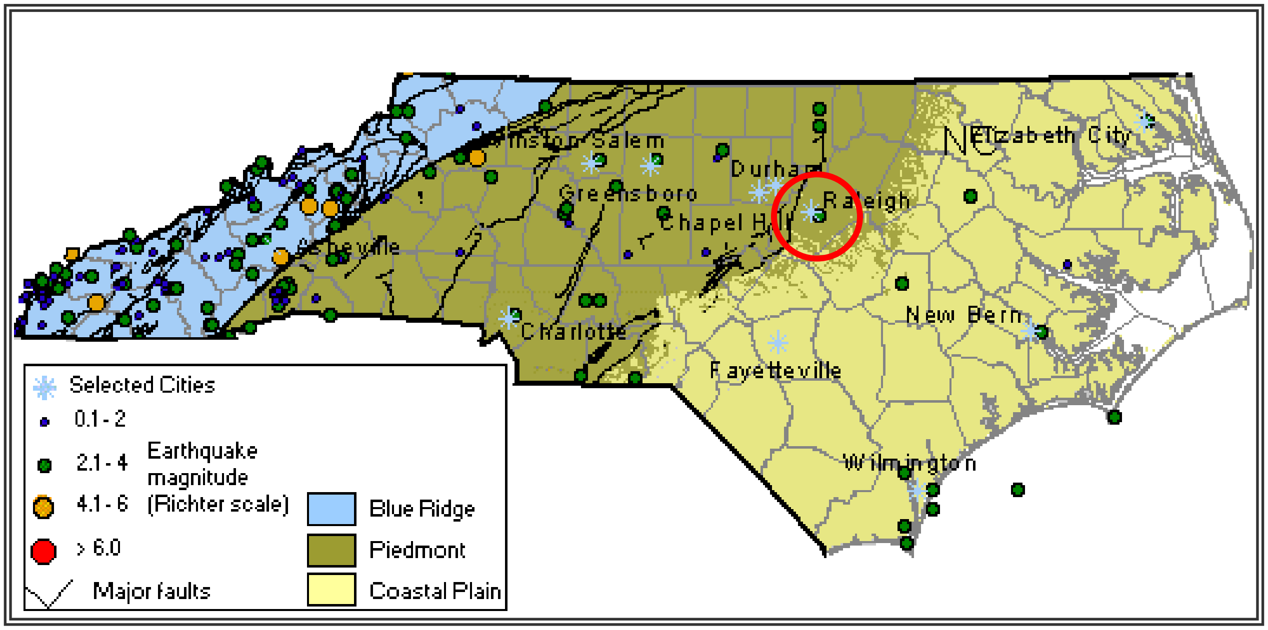
Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and power outages. Furthermore, citizens may resort to using inappropriate heating devices that could to fire or an accumulation of toxic fumes.

Probability of Future Occurrences
Winter storm events will remain a somewhat regular occurrence in Garner due to location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

D.2.9 Earthquake

Location and Spatial Extent
Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina. **Figure D.2** is a map showing geological and seismic information for North Carolina.

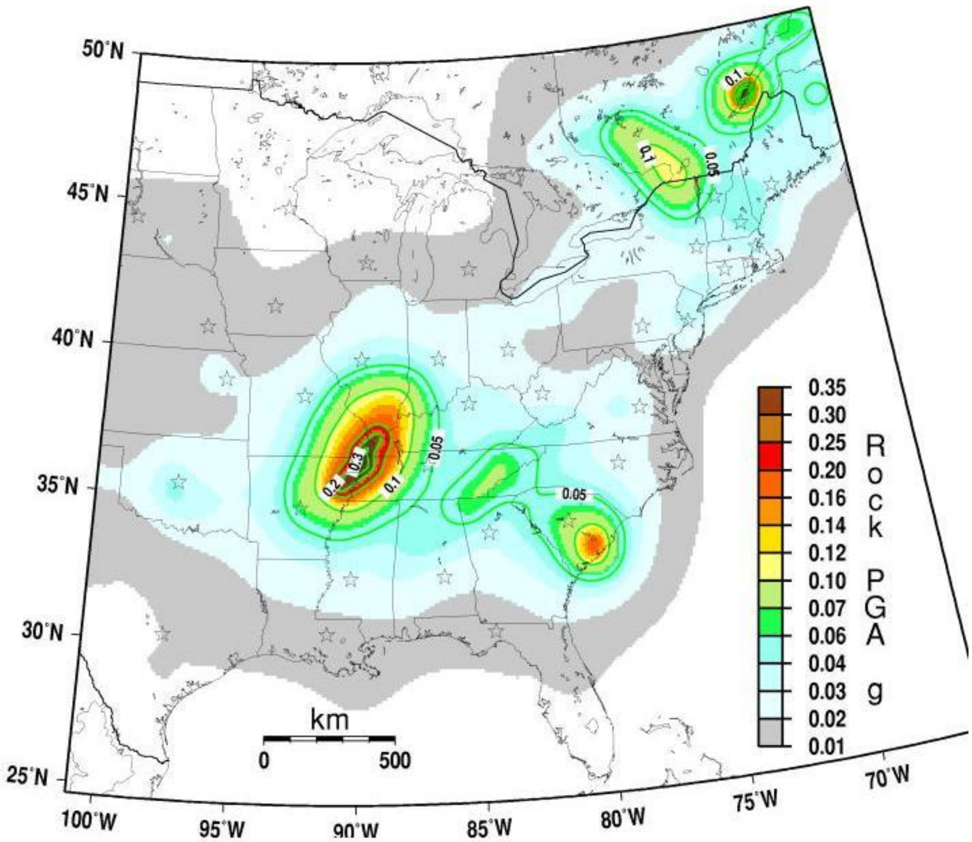
FIGURE D.2: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure D.3 shows the intensity level associated with Garner, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Garner lies within an approximate zone of level "2" to "3" ground acceleration. This indicates that the county exists within an area of moderate seismic risk.

FIGURE D.3: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

Historical Occurrences

Although no earthquakes are known to have occurred directly in Garner since 1874, several have occurred in the county and affected the municipality. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table D.17** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table D.18** presents a detailed occurrence of each event including the date, distance for the epicenter, and Modified Mercalli Intensity (if known). [11]

TABLE D.17: SUMMARY OF SEISMIC ACTIVITY IN GARNER

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Garner	--	--	--

Source: National Geophysical Data Center

[11] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

TABLE D.18: SIGNIFICANT SEISMIC EVENTS IN GARNER (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI (magnitude)
Garner				
None reported				

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Garner, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table D.19.**

TABLE D.19: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 - 1	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928*	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957*	Buncombe County, NC	3.7	VI	VI
11/24/1957*	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973*	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Garner occurrences.
** Conflicting reports on this event, intensity in North Carolina could have been either V or VI
Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Garner is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. The annual probability level for the county is estimated between 1 and 10 percent (possible).

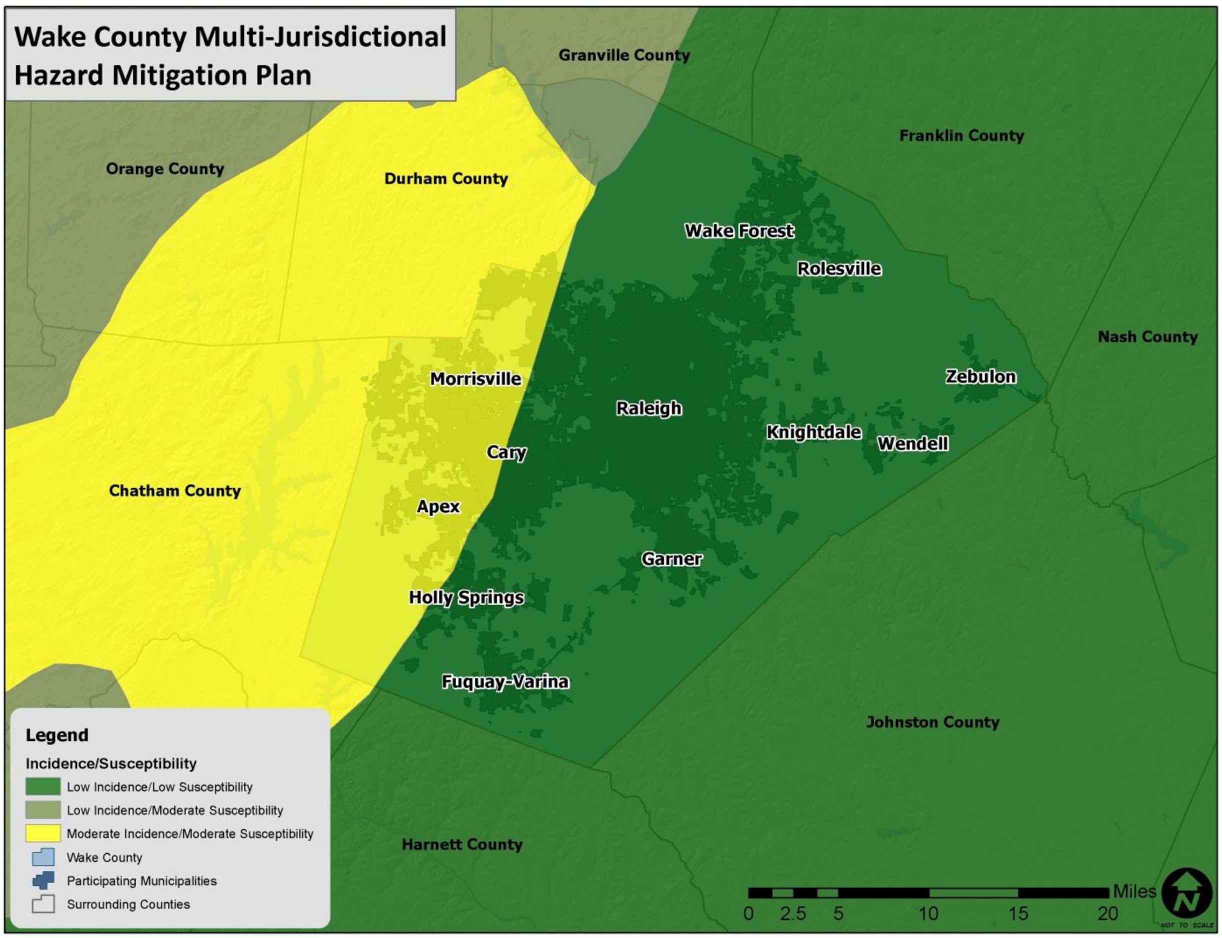
D.2.10 Landslide

Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Garner, although the overall risk is relatively low.

According to **Figure D.4** below, the majority of the county has low landslide activity. However there is a small area along the western border of the county that has a moderate incidence and moderate susceptibility. In all other areas (including all of Garner), there is low susceptibility.

FIGURE D.4: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

Historical Occurrences

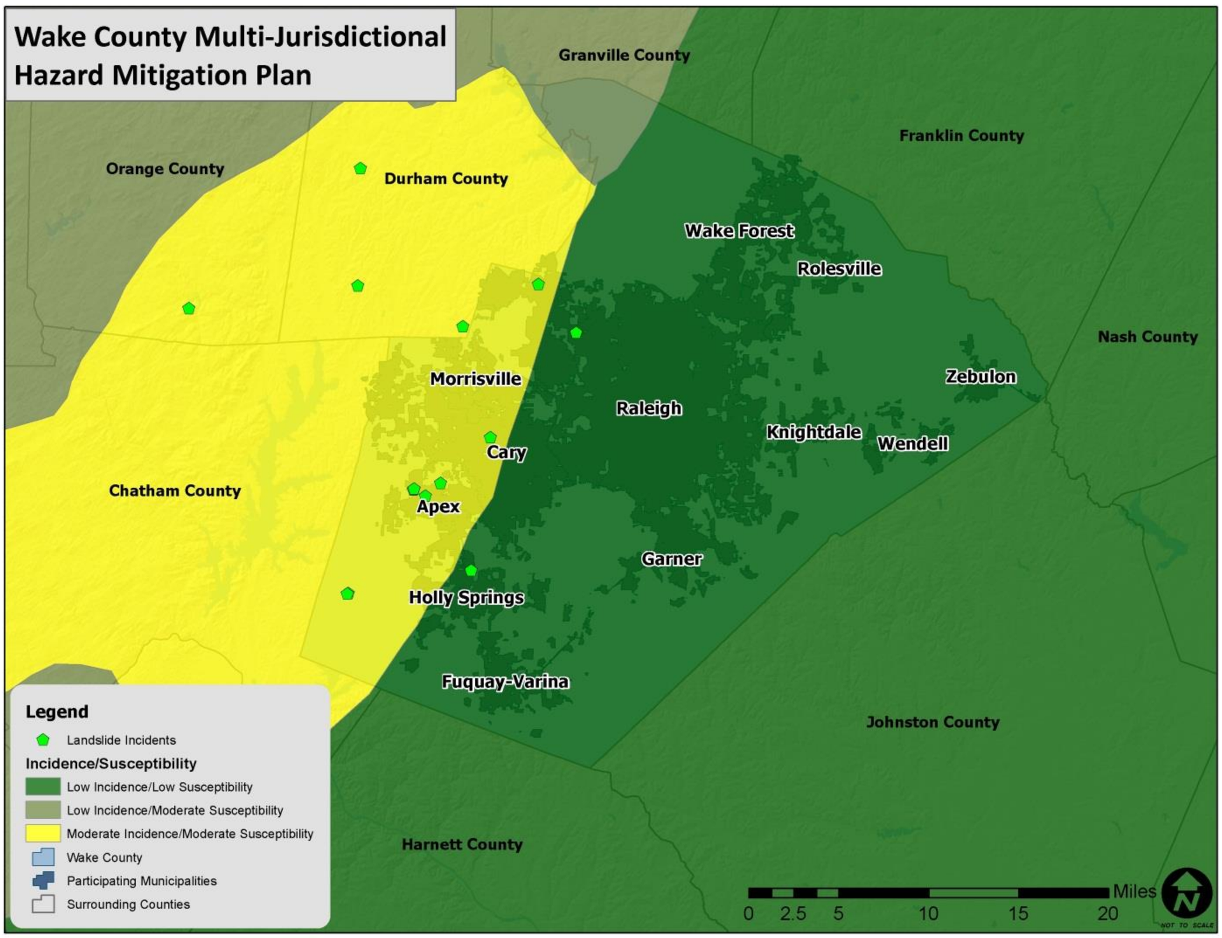
Steeper topography in some areas of Garner make the planning area susceptible to landslides. Most landslides are caused by heavy rainfall in the area. Building on steep slopes that was not previously possible also contributes to risk. **Table D.20** presents a summary of the landslide occurrence events as provided by the North Carolina Geological Survey[12]. The georeferenced locations of the landslide events presented in the aforementioned tables are presented in **Figure D.5**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred in Garner.

TABLE D.20: SUMMARY OF LANDSLIDE ACTIVITY IN GARNER

Location	Number of Occurrences
Garner	3

Source: North Carolina Geological Survey

FIGURE D.5: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for

[12] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Garner have greater risk than others given factors such as steepness on slope and modification of slopes.

D.2.11 Dam and Levee Failure

Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table D.21** explains these classifications.

TABLE D.21: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

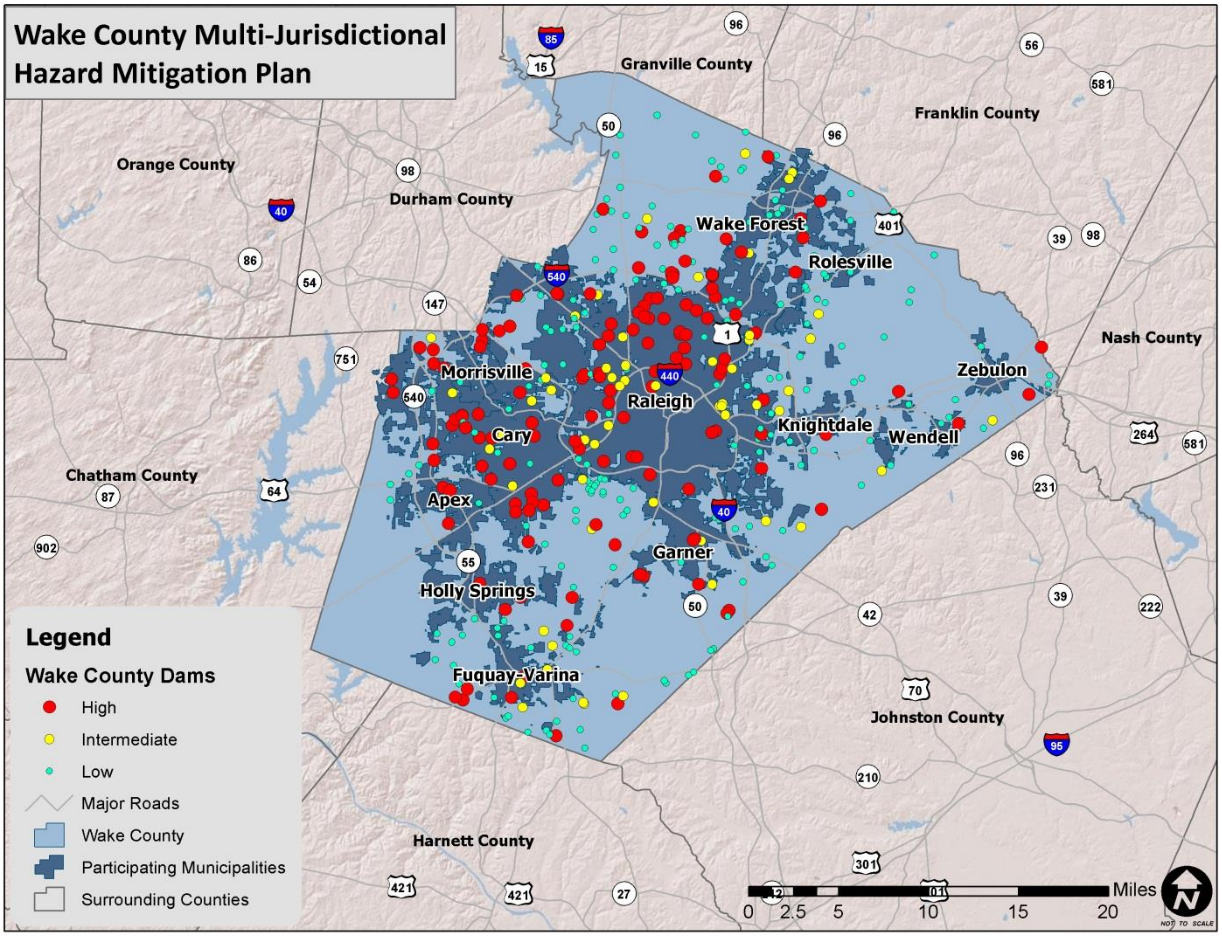
Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

According to the North Carolina Division of Land Management there are 7 dams in Garner.[13] **Figure D.6** shows the dam location and the corresponding hazard ranking for each. Of these dams, four are classified as high hazard potential. These high hazard dams are listed in **Table D.22**.

[13] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE D.6: WAKE COUNTY DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE D.22: GARNER HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Garner				
Massengill Dam	High	6	82	Private
Eagle Ridge Golf Course Dam	High	5.9	0	Private
Weston #1	High	0	10.8	
Weston #2	High	0	10	

Source: North Carolina Division of Land Resources, 2012

It should also be noted that the North Carolina dam classification regulations were recently updated. As a result of the change, more dams are generally classified as high hazard.

Historical Occurrences

No dam breaches were reported in Garner. However, several breach scenarios in the jurisdiction could cause substantial damage.

Probability of Future Occurrences

Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

D.2.12 Erosion

Location and Spatial Extent

Erosion in Garner is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Garner soils have greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Garner, particularly along the banks of rivers and streams, but it is not an extreme threat. No areas of concern were reported by the planning committee.

Historical Occurrences

Several sources were vetted to identify areas of erosion in Garner. This includes searching local newspapers, interviewing local officials, and reviewing the previous hazard mitigation plan. Little information could be found and erosion was not addressed in the previous Garner hazard mitigation plan.

Probability of Future Occurrences

Erosion remains a natural, dynamic, and continuous process for Garner, and it will continue to occur. The annual probability level assigned for erosion is possible (between 1 and 10 percent annually).

D.2.13 Flood

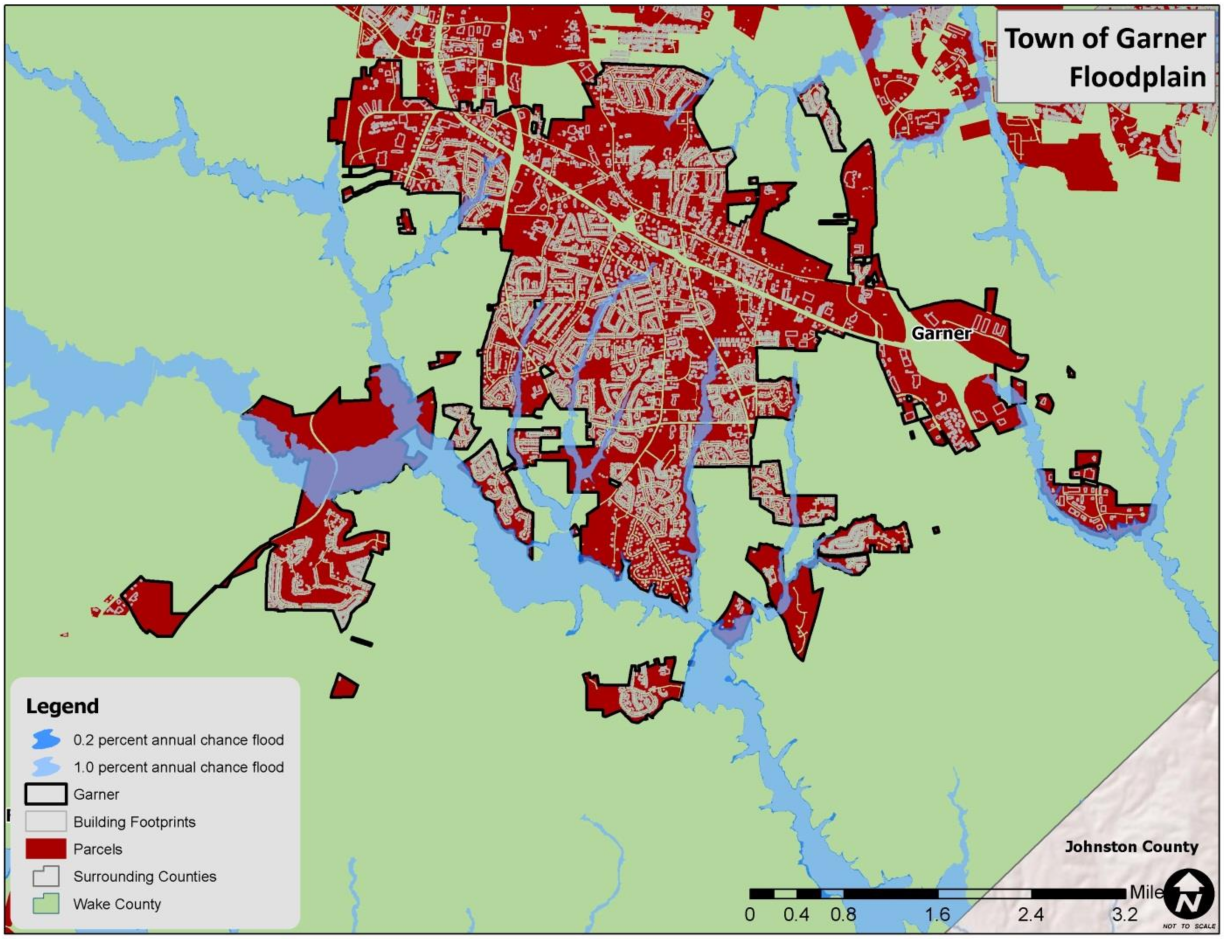
Location and Spatial Extent

There are areas in Garner that are susceptible to flood events. Special flood hazard areas in the jurisdiction were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[14] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 15 square miles that make up Garner, there are 1.10 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain).

These flood zone values account for 7.3 percent of the total land area in Garner. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas. **Figure D.7** illustrates the location and extent of currently mapped special flood hazard areas for Garner based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.

[14] The county-level DFIRM data used for Garner were updated in 2010.

FIGURE D.7: SPECIAL FLOOD HAZARD AREAS IN GARNER



Source: Federal Emergency Management Agency

Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported a total of 1 event in Garner since 1993.[15] A summary of these events is presented in **Table D.23**. This event accounted for $0 (2013 dollars) in property damage in the county.[16] Specific information on flood events, including date, type of flooding, and deaths and injuries, can be found in **Table D.24**.

TABLE D.23: SUMMARY OF FLOOD OCCURRENCES IN GARNER

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Garner	1	0/0	$0

Source: National Climatic Data Center

[15] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.
[16] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

TABLE D.24: HISTORICAL FLOOD EVENTS IN GARNER

	Date	Type	Deaths/ Injuries	Property Damage*
Garner				
Garner	6/11/2006	FLASH FLOOD	0/0	$0

Source: National Climatic Data Center

Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there have been 18 flood losses reported in Garner through the National Flood Insurance Program (NFIP) since 1978. A summary of these figures for the county is provided in **Table D.25**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that additional instances of flood loss in Garner were either uninsured, denied claims payment, or not reported.

TABLE D.25: SUMMARY OF INSURED FLOOD LOSSES IN GARNER

Location	Flood Losses	Claims Payments
Garner	18	$107,854

Source: FEMA, NFIP

Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

As of July 2013, there are 4 non-mitigated repetitive loss properties located in Garner, which accounted for 8 losses and $65,416 in claims payments under the NFIP. Without mitigation, repetitive loss properties will likely continue to experience flood losses. **Table D.26** presents detailed information on repetitive loss properties and NFIP claims and policies for Garner.

TABLE D.26: SUMMARY OF REPETITIVE LOSS PROPERTIES IN GARNER

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Garner	4	4 single family	8	$64,119	$1,297	$65,416	$8,177

Source: National Flood Insurance Program

Probability of Future Occurrences

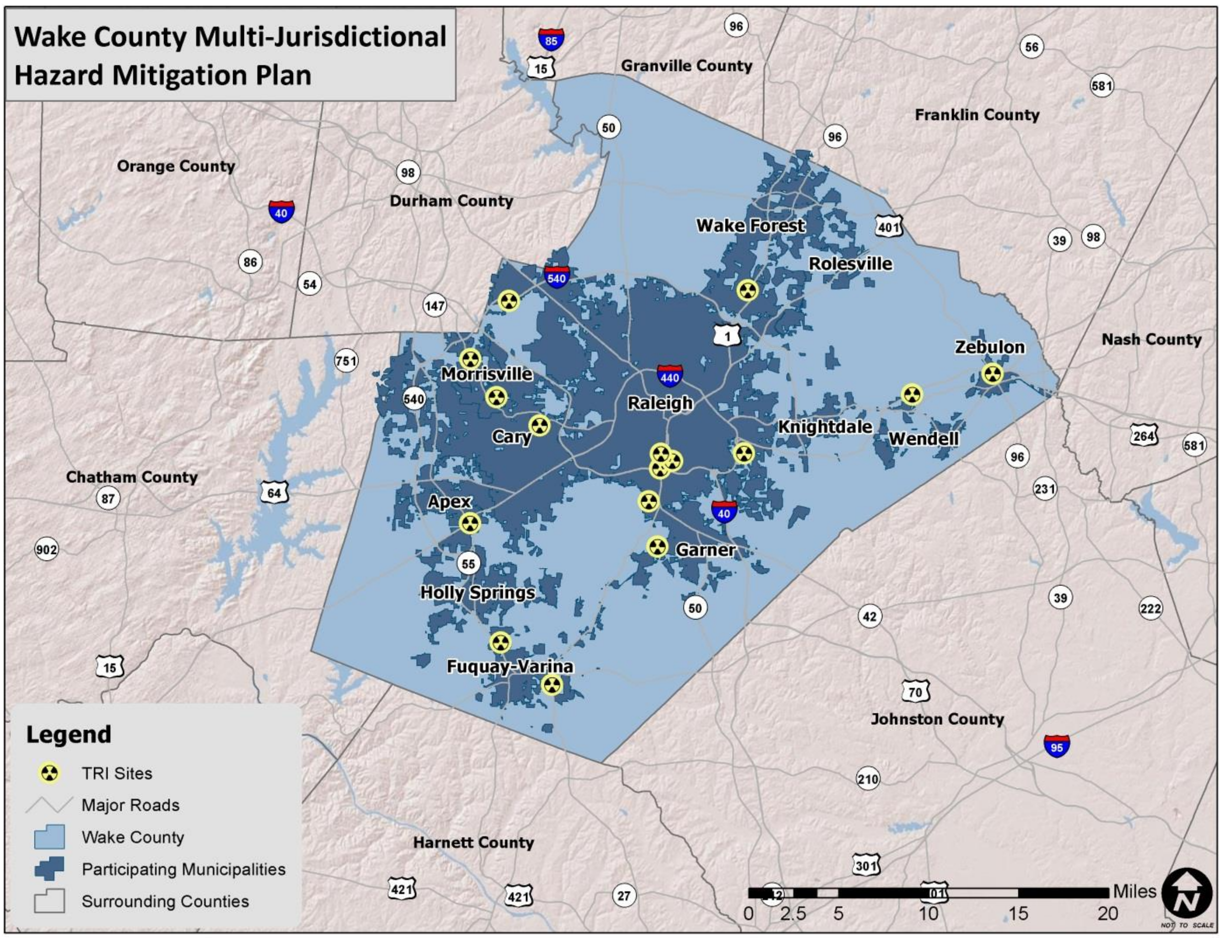
Flood events will remain a threat in areas prone to flooding in Garner, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability) The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above, which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

D.2.14 Hazardous Materials Incidents

Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Garner has no TRI sites as shown in **Figure D.8.**

FIGURE D.8: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the jurisdiction via roadways and rail. All roads that permit hazardous material transport are considered potentially at risk to an incident.

Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table D.27 presents detailed information on historic HAZMAT incidents reported in Garner.

TABLE D.27: SUMMARY OF HAZMAT INCIDENTS IN GARNER

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Garner							
None reported							

Source: USDOT PHMSA

Probability of Future Occurrences

Given the location of one toxic release inventory site in Garner and several roadways and rails that transport hazardous materials, it is possible that a hazardous material incident may occur in the jurisdiction (between 1 percent and 10 percent annual probability). Local officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

D.2.15 Wildfire

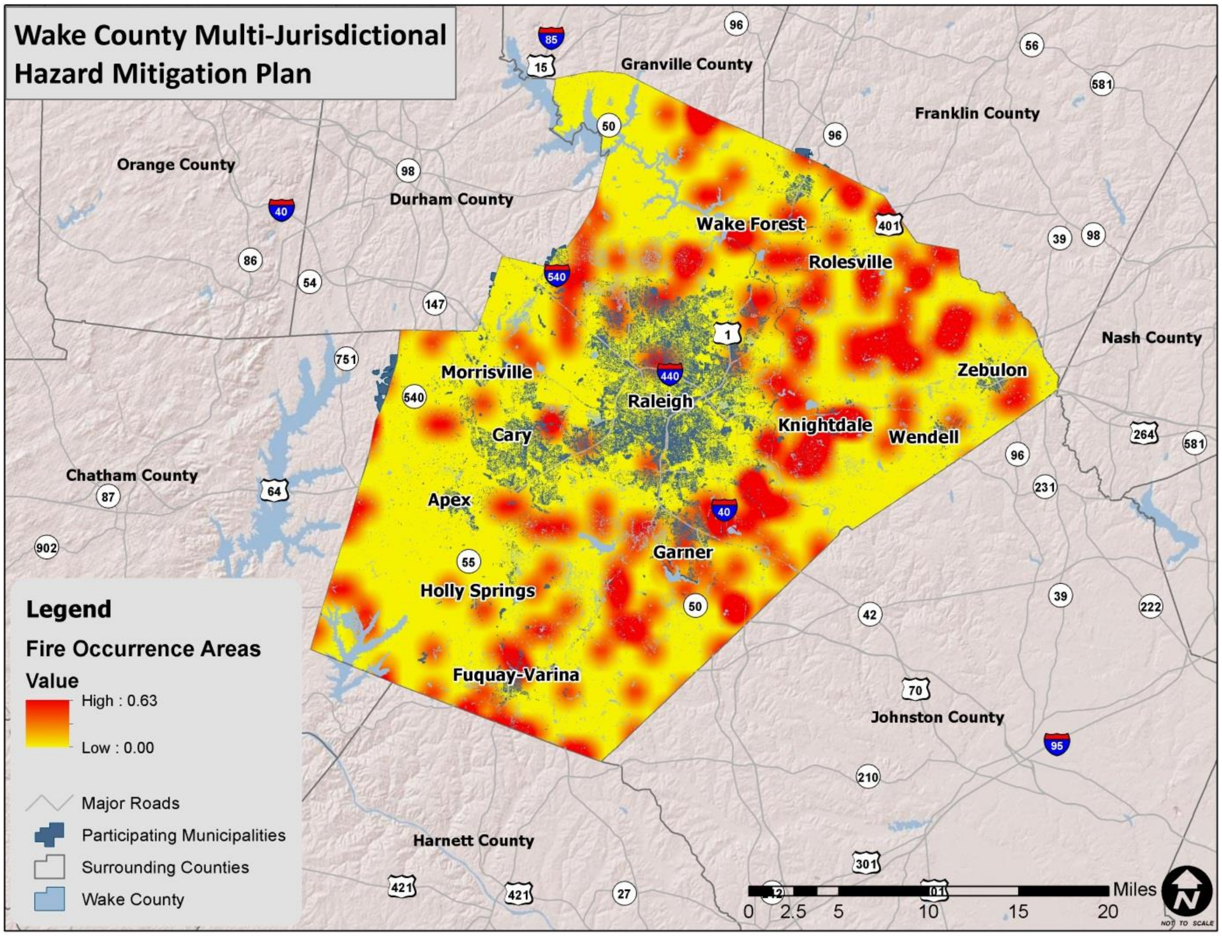
Location and Spatial Extent

The entire jurisdiction is at some risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas.

Historical Occurrences

Figure D.9 shows the Fire Occurrence Areas (FOA) in Garner based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. Therefore, even areas classified as at relatively high risk within the county are a relatively low risk compared to other areas of the state.

FIGURE D.9: HISTORIC WILDFIRE EVENTS IN GARNER



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of 16 wildfires annually which burn an average of 98 acres per year. The data indicates that most of these fires are small, averaging six acres per fire. **Table D.28** lists the number of reported wildfire occurrences in the county between the years 2003 and 2012.

TABLE D.28: HISTORICAL WILDFIRE OCCURRENCES IN GARNER

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Garner. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Garner for future wildfire events is possible (a 1 and 10 percent annual probability).

D.2.16 Nuclear Accident

Location and Spatial Extent

The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station.

Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 "Alerts" and 28 "Notice of Unusual Events" since 1986, which are shown in **Table D.29**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table D.29: Shearon Harris Emergency Declaration History

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on "B" Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).

Emergency Declaration	Date	Description
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of "A" Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - "B" diesel generator was being worked on; in accordance with test procedures, "A" diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported "Notice of Unusual Events" since 1986, which is shown in **Table D.30**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table D.30: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Probability of Future Occurrences

A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

D.2.17 Terror Threat

Location and Spatial Extent

A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table D.31** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

TABLE D.31 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food	▪ Government Facilities
▪ Banking and Finance	▪ Healthcare and Public Health
▪ Chemical	▪ Information Technology
▪ Commercial Facilities	▪ National Monuments and Icons
▪ Communications	▪ Nuclear Reactors, Materials, and Waste
▪ Critical Manufacturing	▪ Postal and Shipping
▪ Dams	▪ Transportation Systems
▪ Defense Industrial Base	▪ Water
▪ Emergency Services	
▪ Energy	

Historical Occurrences

Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

Probability of Future Occurrences

Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

D.2.18 Conclusions on Hazard Risk

The hazard profiles presented above were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and

experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

Hazard Extent

Table D.32 describes the extent of each natural hazard identified for Garner. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE D.32 EXTENT OF GARNER HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page D:4). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Garner has received this ranking three times over the fourteen year reporting period.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Garner was 1.75 inches. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), Garner is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Thunderstorm Wind/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Garner was reported at 56 knots (approximately 64 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). The greatest magnitude reported was an F2 (reported on March 20, 1998).
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Garner. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is low in Garner.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). Of the 7 dams in Garner, 4 are classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records located in Garner.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 7.3 percent of the total land area in Garner. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second.
Other Hazards	
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incident reported in the region is 75 LGA released on the highway in Raleigh. It should be noted that larger events are possible.
Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).
Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

Priority Risk Index Results

In order to draw some meaningful planning conclusions on hazard risk for Garner, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). More information on the PRI and how it was calculated can be found in Section 5.20.2.

Table D.33 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups and Coordinating Committee. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE D.33: SUMMARY OF PRI RESULTS FOR GARNER

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	**2.5**
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	**2.4**
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	**2.5**
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	**2.1**
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	**3.1**
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.7**
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	**2.5**
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2**
Landslide	Unlikely	Minor	Small	Less than 6 hours	Less than 6 hours	**1.5**
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	**1.8**
Flood	Likely	Critical	Small	6 to 12 hours	Less than 1 week	**2.8**
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	**2**
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	**2.6**
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	**2.4**

D.2.16 Final Determinations on Hazard Risk

The conclusions drawn from the hazard profiling process for Garner, including the PRI results and input from the Regional Work Groups and Coordinating Committee, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table D.34**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Garner. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment* and below in Section D.3. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE D.34: CONCLUSIONS ON HAZARD RISK FOR GARNER

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Nuclear Accident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

D.3 TOWN OF GARNER VULNERABILITY ASSESSMENT

This subsection identifies and quantifies the vulnerability of Garner to the significant hazards previously identified. This includes identifying and characterizing an inventory of assets in the county and assessing the potential impact and expected amount of damages caused to these assets by each identified hazard event. More information on the methodology and data sources used to conduct this assessment can be found in Section 6: *Vulnerability Assessment*.

D.3.1 Asset Inventory

Table D.35 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for Garner (study area of vulnerability assessment).[17]

TABLE D.35: IMPROVED PROPERTY IN GARNER

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Garner	9,882	$2,530,181,294	9,185	$1,799,801,899

Table D.36 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in Garner. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. In addition, a list of secondary facilities was created to recognize the importance of these facilities in the event of a disaster. These facilities were not mapped, but it is important to recognize that they could be potentially impacted by nearly any of the identified hazards, especially those that are atmospheric or have no specific spatial delineation.

All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure D.10** shows the locations of the primary critical facilities in Wake County. **Table D.48**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility. As noted previously, this list is not all-inclusive and only includes information provided by the local government.

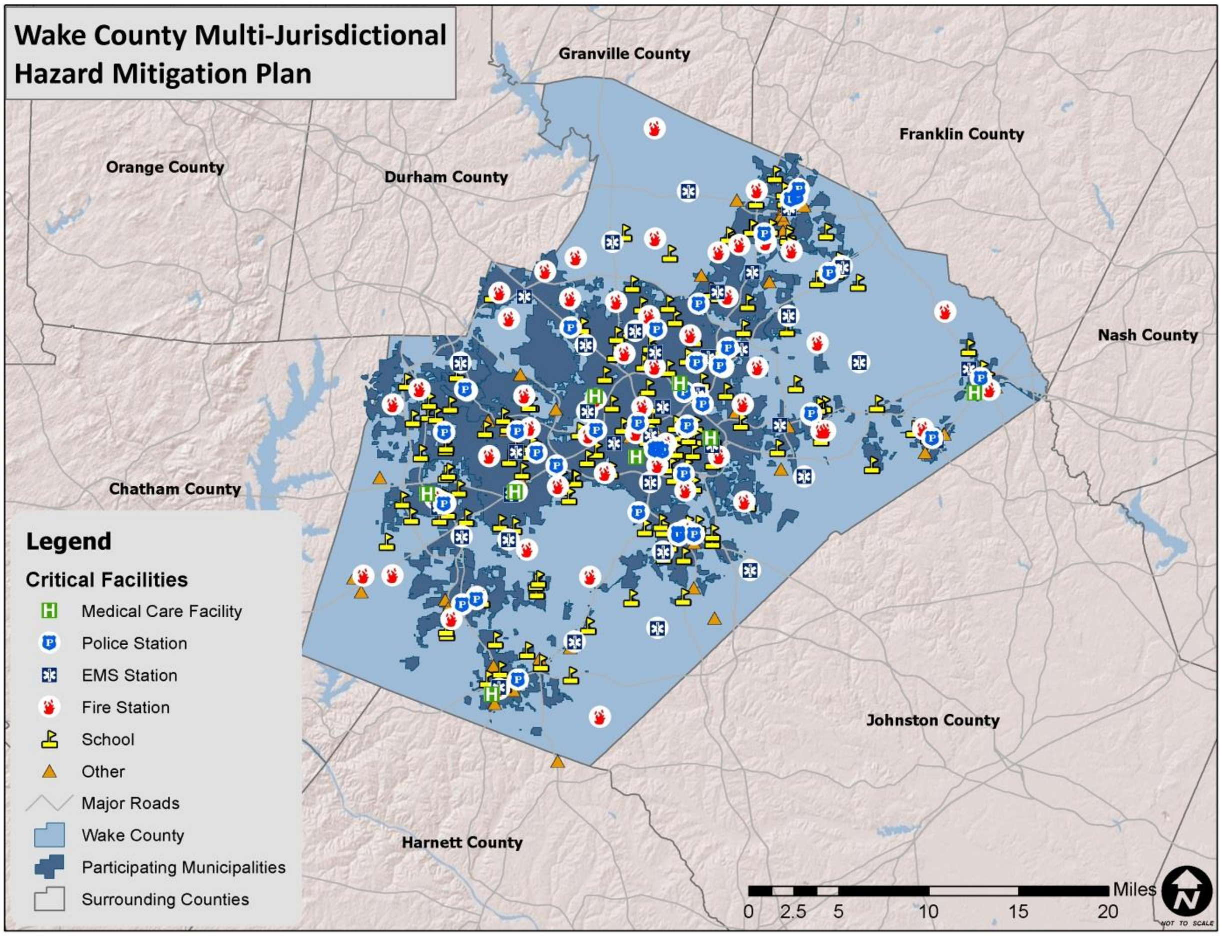
TABLE D.36: CRITICAL FACILITY INVENTORY IN GARNER

Location	Fire Stations	Police Stations	EMS Stations	Medical Care Facilities	Schools	Other
Garner	3	5	2	0	9	3

Source: Local Governments

[17] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

FIGURE D.10: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: Local Governments

D.3.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Garner that are potentially at risk to these hazards.

Table D.37 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, limited the results to county-wide estimates. The total population in Garner according to Census data is 25,745 persons. Additional population estimates are presented above in Section D.1.

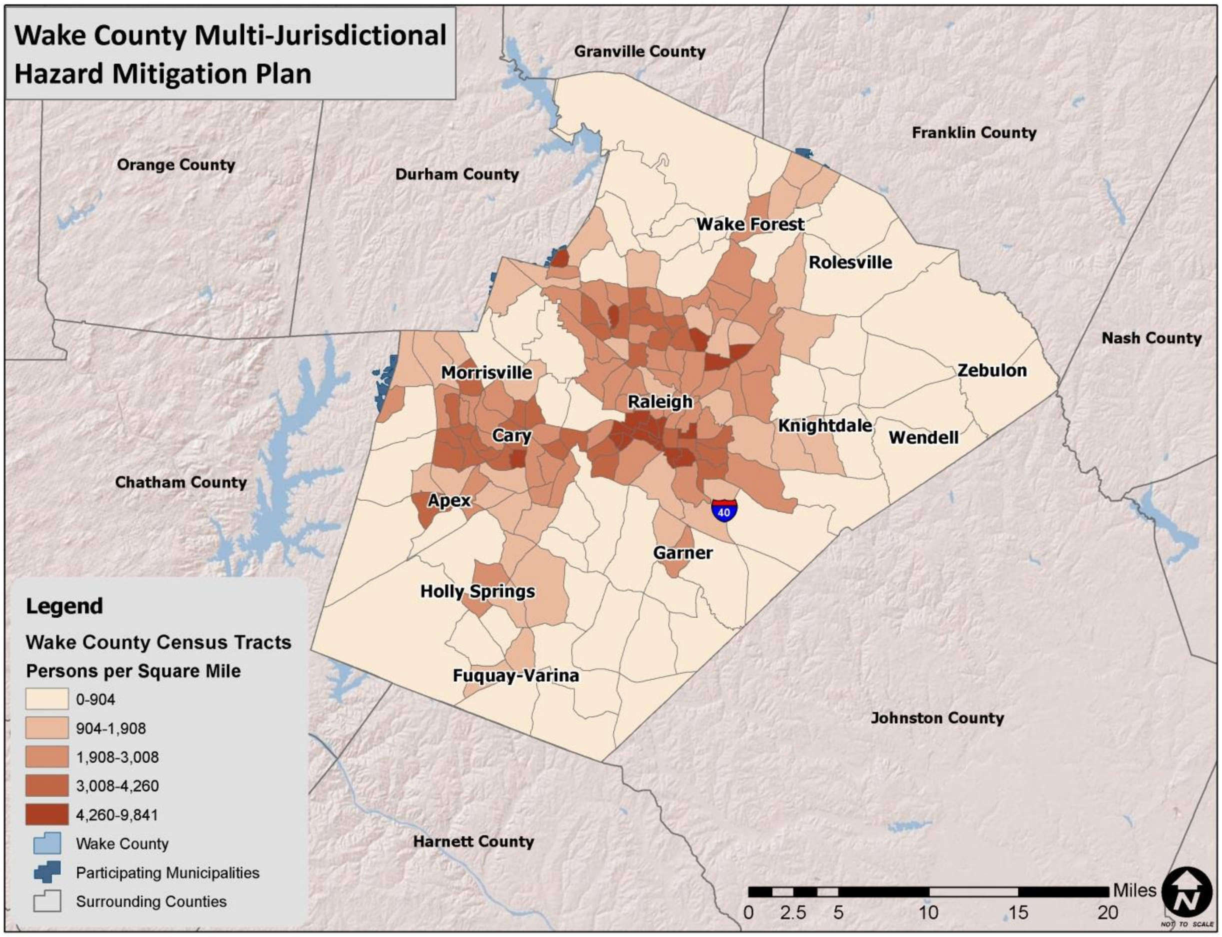
TABLE D.37: TOTAL POPULATION IN GARNER

Location	Total 2010 Population
Garner	25,745

Source: U.S. Census 2010

In addition, **Figure D.11** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[18]

FIGURE D.11: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

D.3.3 Vulnerability Assessment Results

As noted in Section 6: *Vulnerability Assessment*, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results, specific to Garner, are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total county exposure, and thus risk, was presented in **Table D.35**.

The annualized loss estimate for all hazards is presented at the end of this section in **Table D.47.**

The hazards presented in this section include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

[18] Population by census block was not available at the time this plan was completed.

Hurricane and Tropical Storm

Historical evidence indicates that Garner has a significant risk to the hurricane and tropical storm hazard. Several tracks have come near or traversed through the county, as shown and discussed in Section D.2.4.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes, and high winds and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table D.38.** Only losses to buildings are reported, in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE D.38: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table D.39.**

TABLE D.39: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Garner	76.2	85.6	104.6	111.2

Source: Hazus-MH 2.1

Social Vulnerability

Given equal susceptibility across the county, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Garner, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table D.48** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Garner. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

Earthquake

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table D.40** summarizes the findings.

TABLE D.40: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability

It can be assumed that all existing future populations are at risk to the earthquake hazard.

Critical Facilities

The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table D.48**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Garner. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

Landslide

In order to complete the vulnerability assessment for landslides in Garner, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section D.2.10), tax parcel and building footprint data, and GIS analysis. **Table D.41** presents the potential at-risk property where available. All areas of Garner are identified as low incidence areas by the USGS landslide data. Since there were no high incidence levels in the county, the moderate incidence level was used to identify different areas of concern for the analysis below.

TABLE D. 41: TOTAL POTENTIAL AT-RISK PARCELS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	Moderate		
Garner	0	0	$0

Source: USGS

Social Vulnerability
Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides.

Critical Facilities
No critical facilities are located in a moderate susceptibility area. A list of specific critical facilities and their associated risk can be found in **Table D.48** at the end of this section.

In conclusion, a landslide has the potential to impact existing and future buildings, facilities, and populations in Garner, though some areas are at a higher risk than others due to a variety of factors. For example, steep slopes and modified slopes bear a greater risk than flat areas. Specific vulnerabilities for county assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

Flood
Historical evidence indicates that Garner is susceptible to flood events. A total of 1 flood event has been reported by the National Climatic Data Center resulting in $0 in damages. On an annualized level, these damages amounted to $0 for Garner.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for the county. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table D.42** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

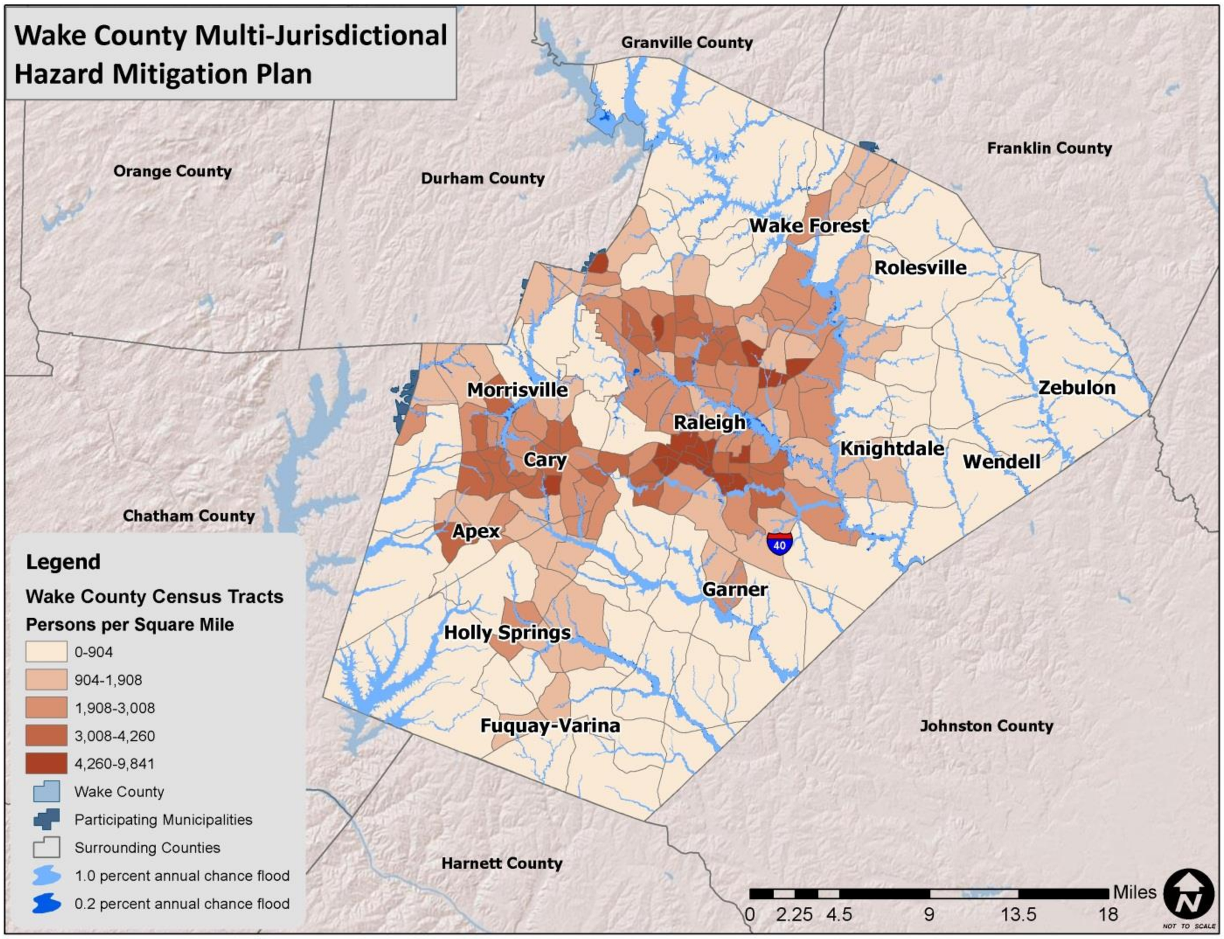
TABLE D.42: ESTIMATED EXPOSURE OF PARCELS TO THE FLOOD HAZARD

Location	1.0-percent ACF			0.2-percent ACF		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings
Garner	485	113	$91,838,660	53	59	$14,149,371

Source: FEMA DFIRM

Social Vulnerability
Since 2010 population was available at the tract level, it was difficult to determine a reliable figure on population at-risk to flood due to tract level population data. **Figure D.12** is presented to gain a better understanding of at risk population.

FIGURE D.12 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities

The critical facility analysis revealed that there are a no critical facilities located in the Garner 1.0-percent annual chance floodplain and 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. A list of specific critical facilities and their associated risk can be found in **Table D.48** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings and populations in Garner, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

<u>Hazardous Materials Incident</u>

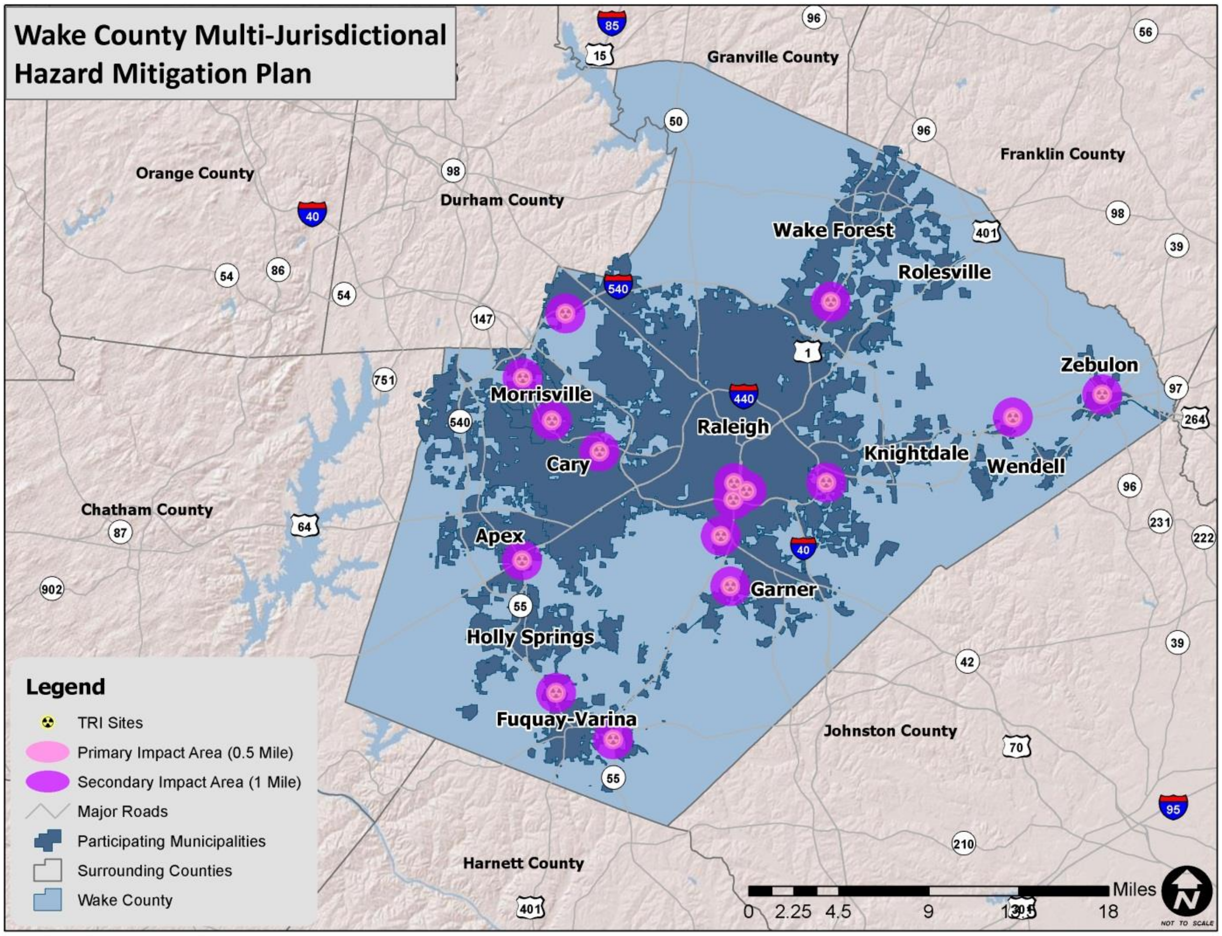
Although historical evidence and existing Toxic Release Inventory sites indicate that Garner is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Garner.

Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[19] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Garner, along with buffers, were used for analysis as shown in **Figure D.13.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the GIS buffer analysis. **Figure D.14** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table D.43** (fixed sites), **Table D.44** (mobile road sites) and **Table D.45** (mobile railroad sites).[20]

[19] This type of analysis will likely yield inflated results (generally higher than what is actually reported after an event).
[20] Note that parcels included in the 1.0-mile analysis are also included in the 0.5-mile analysis.

FIGURE D.13 : TRI SITES WITH BUFFERS IN GARNER



Source: EPA

TABLE D.43: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Garner	99	77	$50,611,119	901	808	$206,577,359

FIGURE D.14 : MOBILE HAZMAT BUFFERS IN GARNER

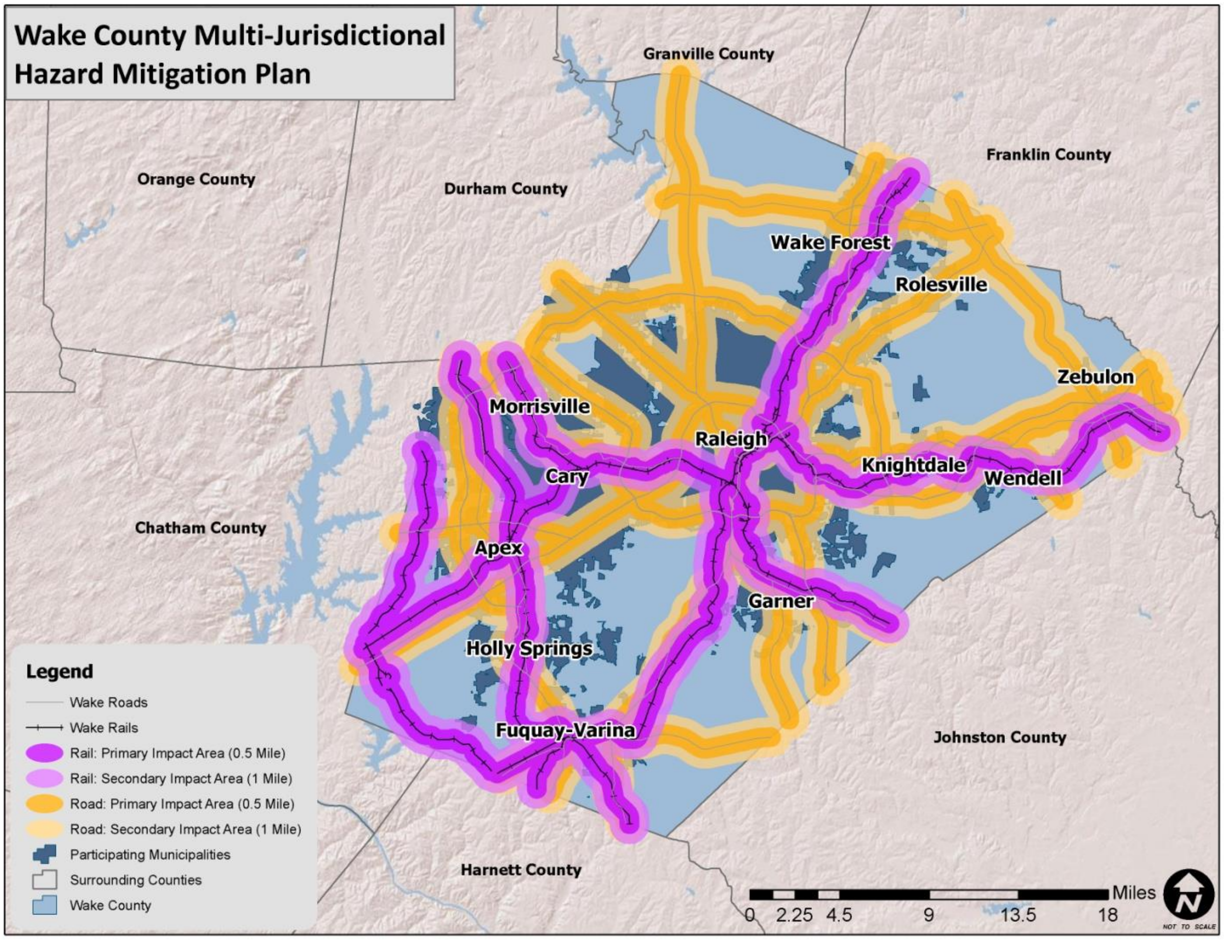


TABLE D.44: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Garner	4,269	3,895	$925,335,883	7,473	6,772	$1,423,945,580

TABLE D.45: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Garner	2,369	2,286	$559,538,532	5,107	4,843	$1,047,259,512

Social Vulnerability

Given high susceptibility across the jurisdiction, it is assumed that the total population is at risk to a hazardous materials incident. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities

Fixed Site Analysis:

The critical facility analysis for fixed TRI sites revealed that 4 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes just 1 facility, a police station. The remaining facilities are in the secondary, 1.0-mile zone. A list of specific critical facilities and their associated risk can be found in **Table D.48** at the end of this section.

Mobile Analysis:

The critical facility analysis for road and railroad transportation corridors in Garner revealed that there are 19 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 12 facilities. The remaining facilities are in the secondary, 1.0-mile zone. The railroad buffer areas include 14 facilities with 10 in the primary impact zone. It should be noted that many of the facilities located in the buffer areas for railroad are also located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table D.48** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Garner. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc. Further, incidents from neighboring jurisdictions could also have an impact.

Wildfire

Although historical evidence indicates that Garner is susceptible to wildfire events, there are few reports of damage. Upon conversion of the wildfire risk data (see Section 6: *Vulnerability Assessment*) and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the jurisdiction should be assumed to be very low. As such, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the county.

Social Vulnerability

All areas have relatively equal vulnerability and there is low susceptibility across the entire county.
It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in wildfire areas of concern. It should be noted, however, that several factors could impact the spread of a wildfire putting all facilities at risk. A list of specific critical facilities and their associated risk can be found in **Table D.48** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Garner.

Nuclear Accident

The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table D.46** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE D.46: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[21]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[22]
Garner	12,107	9,794	$2,617,633,591	13,428	11,097	$2,987,895,360

Social Vulnerability

Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities

The critical facility analysis revealed that there are a total of eighteen critical facilities located in the 10-mile nuclear buffer area including 2 EMS stations, 3 fire stations, 1 police station, 1 medical care facility, 7 schools, and 4 others in Garner.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in Garner, though areas closer to the power plant are at a higher risk than others. All structures are at some risk given that they are all located within at least the 50-mile buffer area.

Conclusions on Hazard Vulnerability

Table D.47 presents a summary of annualized loss for each hazard in Garner. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, although an annualized loss was determined through the

[21] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.
[22] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

damage reported through historical occurrences at the municipal level, it is likely that the county-wide estimate (found in Section 6: *Vulnerability Assessment*) is potentially a better estimate. These values should be used as an additional planning tool or measure risk for determining hazard mitigation strategies.

TABLE D.47: ANNUALIZED LOSS FOR GARNER*

Event	Garner
Dam Failure	Negligible
Drought	Negligible
Erosion	Negligible
Extreme Heat	Negligible
Hail	Negligible
Hurricane & Tropical Storm	Negligible
Landslide	Negligible
Lightning	Negligible
Thunderstorm Wind/High Wind[23]	Negligible
Tornado	$69,132
Winter Storm & Freeze	Negligible
Flood	Negligible
Earthquake	Negligible
HAZMAT Incident	Negligible
Wildfire	Negligible
Nuclear Accident	Negligible
Terror Threat	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table D.48** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

[23] The annualized losses for these hazards were combined.

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TABLE D.48: AT-RISK CRITICAL FACILITIES IN GARNER

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
GARNER																								
GARNER MAIN	EMS STATION	X	X	X	X	X	X	X	X	X						X							X	X
GARNER EAST	EMS STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
GARNER #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
GARNER #3	FIRE STATION	X	X	X	X	X	X	X	X	X						X							X	X
GARNER #4	FIRE STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
PUBLIC WORKS BUILDING	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WATER TREATMENT PLANT	OTHER	X	X	X	X	X	X	X	X	X							X	X					X	X
WASTEWATER SPRAY FACILITY	OTHER	X	X	X	X	X	X	X	X	X								X					X	X
GARNER	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
POLICE ANNEX	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
EAST DISTRICT SUBSTATION	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WEST DISTRICT SUBSTATION	POLICE STATION	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X			X	X
POLICE	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
RAND ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
NORTH GARNER MS	SCHOOL	X	X	X	X	X	X	X	X	X								X	X	X			X	X
EAST GARNER MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
EAST GARNER ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
CREECH ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X								X		X			X	X
TIMBER DRIVE ES	SCHOOL	X	X	X	X	X	X	X	X	X						X							X	X
GARNER HS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X		X			X	X
VANDORA SPRINGS ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
AVERSBORO ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X

Secondary Critical Facilities are listed in slight contrast to Critical Facilities as their continued function has not been deemed as critical as primary facilities in the event of a disaster, but these facilities are extremely important. A loss of function to one of these facilities would have a definitively greater negative impact on the community's ability to respond to and recover from a disaster than a loss of function at other facilities/structures within the jurisdiction. In **Table D.49**, these facilities have been classified as either Significant Community Locations/Sheltering Centers or as Critical Resources Management Facilities. These facilities are all vulnerable to any of the atmospheric hazards and many are also likely vulnerable to other hazards identified above, though no locational analysis was carried out to this end.

TABLE D.49: GARNER SECONDARY CRITICAL FACILITIES

Facility Name	Address*	Type
Garner		
Water Tower	140 Rand Mill Road	Critical Resources Management (Energy, Water, etc.)
Water Tower	121 Penny Street	Critical Resources Management (Energy, Water, etc.)
Water Tower	840 East Garner Road	Critical Resources Management (Energy, Water, etc.)
Water Booster Stations	• 2045 W. Garner Road • 501 Mechanical Blvd. • 4567 Jones Sausage Road	Critical Resources Management (Energy, Water, etc.)
Pumping Stations	• 2775 Benson Road • 2390 Aversboro Road • 205 Inkster Cove • 319 St Mellion St • 781 E. Garner Road • 221 E. Garner Road • 1018 N. Spring Garden • 1203 Claymore Drive • 2355 Benson Road • 921 Buffaloe Road • 695 Maxwell Drive • Ten Ten Road and Hwy 401 • 1301 ½ US Hwy 70 • 3960 Junction Road • 2301 Buffaloe Road • 600 Wilton Meadow Road • 5480 Raynor Road • 116 Coassack Circle	Critical Resources Management (Energy, Water, etc.)
US Post Office		Significant Community Location or Sheltering Center
Duke Progress Energy		Critical Resources Management (Energy, Water, etc.)
Duke Progress Energy Central Warehouse/Operations Center		Critical Resources Management (Energy, Water, etc.)

Facility Name	Address*	Type
BellSouth		Critical Resources Management (Energy, Water, etc.)
Senior Citizen Center		Significant Community Location or Sheltering Center
Avery Street Recreation Center		Significant Community Location or Sheltering Center

**Some address information could not be provided or was not applicable to the facility*

D.4 TOWN OF GARNER CAPABILITY ASSESSMENT

This subsection discusses the capability of the Town of Garner to implement hazard mitigation activities. More information on the purpose and methodology used to conduct the assessment can be found in Section 7: *Capability Assessment*.

D.4.1 Planning and Regulatory Capability

Table D.50 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the Town of Garner. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE D.50: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning Tool/Regulatory Tool	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan (Parks & Rec/Greenway Plan	Stormwater Management Plan/Ordinance	Natural Resource Protection Plan	Flood Response Plan	Emergency Operations Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	National Flood Insurance Program (NFIP)	NFIP Community Rating System
Garner	✓	✓		✓	✓			✓	✓			✓			✓	✓	✓	✓		✓	✓	✓	

A more detailed discussion on the town's planning and regulatory capabilities follows.

Emergency Management

Hazard Mitigation Plan
The Town of Garner has previously adopted a hazard mitigation plan.

Emergency Operations Plan
The Town of Garner has adopted the Wake County Emergency Operations Plan. The town also maintains a municipal-level emergency operations plan.

Continuity of Operations Plan
The Town of Garner has adopted a municipal-level continuity of operations plan.

General Planning

Comprehensive Land Use Plan
The Town of Garner has adopted a comprehensive growth management plan.

Capital Improvements Plan
The Town of Garner has a capital improvement budget that includes planned expenditures for major infrastructure projects.

Zoning Ordinance
The Town of Garner includes zoning regulations as part of the local unified development ordinance.

Subdivision Ordinance
The Town of Garner also includes subdivision regulations as part of the local unified development ordinance.

Building Codes, Permitting, and Inspections
North Carolina has a state compulsory building code which applies throughout the state. The building code is enforced within the town's planning jurisdiction by the Town of Garner Inspections Department.

Floodplain Management

Table D.51 provides NFIP policy and claim information for the Town of Garner.

TABLE D.51: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
Garner	07/03/78	04/16/07	131	$30,599,600	18	$107,854

Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Flood Damage Prevention Ordinance
All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. The Town of Garner participates in the NFIP and has adopted flood damage prevention regulations.

Open Space Management Plan
The Town of Garner has adopted a comprehensive parks and recreation, open space, and greenways master plan.

Stormwater Management Plan
The Town of Garner has not adopted a stormwater management plan; however, the town includes stormwater management regulations as part of the local unified development ordinance.

D.4.2 Administrative and Technical Capability

Table D.52 provides a summary of the capability assessment results for the Town of Garner with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in the town with the specified knowledge or skill.

TABLE D.52: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	Planners with knowledge of land development/land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency Manager	Floodplain Manager	Land Surveyors	Scientists familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Resource development staff or grant writers
Garner	✓	✓	✓	✓	✓		✓	✓	✓	

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

D.4.3 Fiscal Capability

Table D.53 provides a summary of the results for the Town of Garner with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plan.

TABLE D.53: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes (or taxing districts)	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.
Garner	✓	✓	✓					✓	✓	✓

D.4.4 Political Capability

The previous hazard mitigation plan indicates that the citizens, property owners, business owners, and elected officials of the Town of Garner are committed to improving the greater community through coordinated hazard mitigation planning efforts. In the coming years, the Town of Garner will continue to take a proactive role in planning for and encouraging mitigation of hazards that put citizens and property at risk. The Mayor of Garner along with the elected Town Council members continually strive to make the Town of Garner a safer community and see the hazard mitigation plan as an essential component in helping to achieve that goal.

D.4.5 Conclusions on Local Capability

Table D.54 shows the results of the capability assessment using the designed scoring methodology described in Section 7: *Capability Assessment*. The capability score is based solely on the information found in existing hazard mitigation plan and readily available on the town's government website. According to the assessment, the local capability score for the town is 43, which falls into the high capability ranking.

TABLE D.54: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
Garner	43	High

D.5 TOWN OF GARNER MITIGATION STRATEGY

This subsection provides the blueprint for Garner to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Regional Work Groups and the findings and conclusions of the capability assessment and risk assessment. Additional Information can be found in Section 8: *Mitigation Strategy* and Section 9: *Mitigation Action Plan*.

D.5.1 Mitigation Goals

Garner developed seven mitigation goals in coordination with Wake County and the other participating municipalities. The county-wide mitigation goals are presented in **Table D.55**.

TABLE D.55: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

D.5.2 Mitigation Action Plan

The mitigation actions proposed by Garner are listed in the following Mitigation Action Plan.

Town of Garner Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Institute NPDES Phase II Stormwater Program.	Flood Drought	High	Garner Engineering	High	Completed	This program has been implemented and so the action will be removed from this plan in the next update.
P-2	Evaluate the need for regulations to encourage use of low impact development site planning principles to help control stormwater volume impacts.	Flood, Dam	Moderate	Garner Engineering and Planning	Moderate	2018	Low impact development principles have been evaluated, but more regulations concerning stormwater could improve flood issues.
P-3	Enforce zoning ordinance standards that help minimize impervious surface coverage in priority and healthy watersheds.	Flood	Moderate	Garner Engineering and Planning	Moderate	Completed	This ordinance has been implemented and so the action will be removed from this plan in the next update.
P-4	Continue to ensure good site planning by carefully reviewing development plans, meeting with developers and making site inspections to ensure existing soil erosion and sedimentation control regulations are being implemented properly.	Flood	High	Garner Engineering and Wake County	High	Completed	These regulations have been implemented and so the action will be removed from this plan in the next update.
P-5	Establish an open space prioritization and acquisition program to ensure maximum success with limited funds.	Flood	High	Garner Board of Aldermen and Parks and Recreation	High	Completed	Since the Town of Garner recently developed a 96 acre passive park in 2006-2007 this is no longer at the top of the priority list.
P-6	Partner with Wake County and other interested parties to jointly identify and acquire open space lands.	All Hazards	High	Garner Board of Aldermen and Wake County and Open Space Advisory Committee	High	2018	Planning interlocal agreement with City of Raleigh for stewardship of open space/ conservation property in Garner. This action will be worked on going forward.
P-7	Adopt Comprehensive Land Use Plan that will provide a 20-year plan for town growth and include goals and policies for public safety and hazard mitigation.	All Hazards	High	Garner Planning	High	Completed	The comprehensive plan was adopted in 2006.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-8	UDO: Continue to provide stream and creek buffers, and floodplain and wetland protection.	Flood	High	Garner Planning	High	2017	Stream and creek buffers are in place, but additional measures to protect floodplains and wetlands could be useful going forward.
P-9	UDO: Subdivision Standards – Continue to provide protection for residential areas by not allowing residential lots in the floodplain.	Flood	High	Garner Planning	High	Completed	Residential lots are not allowed in the floodplain so this action will be removed from the next update.
P-10	UDO: Watershed Protection Overlay District – Ensure riparian buffers are provided for perennial and intermittent streams, lakes, and ponds.	Flood	High	Garner Planning and Public Works	High	Completed	Riparian buffers are provided for intermittent streams, lakes, and ponds so this action will be removed from the next update.
P-11	Provide adequate water supply through storage and interconnection with other public water systems.	Drought	Moderate	City of Raleigh and Garner Engineering	Moderate	2018	City of Raleigh utilities currently using Lake Benson as primary water source. Additional water sources should be evaluated going forward.
P-12	Provide backup power for all critical public facilities (Police, Public Works, and other critical public buildings).	All Hazards	Moderate	Garner Administration	Moderate	2019	Town Hall Complex and Public Works completed; New Police Facility planned with generator
P-13	Maintain major town transportation routes through snow and ice removal including experimenting with brine in 2004.	Severe Winter Storms	Moderate	Garner Public Works	Moderate	Completed	Use of brine has proven effective in snow and ice removal. This strategy will be continued in the future.
P-14	On a regular basis, continue to back-up information pertaining to Town government in case of an emergency.	Flood, Hurricane and High winds, Tornado, Winter, Dam	Moderate	Garner Computer Information Services	Moderate	Completed	Critical financial data backed up offsite.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-15	Garner Transportation Plan – Continue to address disaster preparedness (evacuation) through road interconnectivity, paved roads, and widening of roads.	Flood, Hurricane and High winds, Tornado, Winter	Moderate	Garner Planning and Public Works	Moderate	2019	This plan has been implemented, but it will require review and update to account for new development and changes in overall transportation system
P-16	Evaluate ways to amend landscape ordinance requirements regarding the maintenance of pervious surface areas for natural stormwater water detention.	Flood	Moderate	Garner Planning	Moderate	Completed	There has been an informal practice to require this during site approval, particularly as it related to landscaping in BMP's since June 2007
P-17	Incorporate Greenway Plan into Open Space Plan.	Flood	Moderate	Garner Planning and Parks and Recreation	Moderate	Completed	The Greenway plan has been incorporated into the Open Space plan since it was adopted in 2006
P-18	Incorporate requirement for open space set aside in residential and multi-family projects.	Flood	Moderate	Garner Planning	Moderate	Completed	There is a requirement for open space set-asides in residential and multi-family projects.
P-19	Develop for public dissemination building inspections brochures regarding high winds, water damage prevention, and tie downs for accessory structures.	Flood, Hurricane and High winds, Tornado, Winter	Moderate	Garner Inspections	Moderate	2018	The Town website was recently redesigned and this information was not included. Going forward, more information will be included on reducing damage and mitigation.
P-20	Building Code - The Town administers a program upholding the 2002 International Building Code with North Carolina Amendments. These regulations provide guidance for design criteria for flood, roof snow load, winter design, wind speed, seismic design, weathering, frost line depth, termite infestation, and decay.	Flood, Hurricane and High winds, Tornado, Winter	High	Garner Inspections	High	Completed	The town administers the NC Building Code so this action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-21	Comprehensive Growth Plan - The Town has an existing Comprehensive Plan which includes Land Use, Parks and Recreation, Public Safety, Housing, economic Development, Transportation, Public Utilities and Environment. This plan includes past and current conditions and sets goals for future needs of the Town.	All Hazards	Moderate	All	Moderate	Completed	The town has its Comprehensive Growth Plan in place so this action will be removed from the next update.
P-22	Land Use Plan - An existing tool which guides development based on proposed future land use designations, available services, and existing site features to ensure that future development is meeting the overall vision of the Town while ensuring the safety of citizens.	Flood, Hurricane and High winds, Tornado, Winter, Wildfire, Dam	High	Garner Planning	High	Completed	The town has its Land Use Plan in place so this action will be removed from the next update.
P-23	Floodplain Development Regulations – Ordinance to minimize public and private losses due to flood conditions.	Flood	High	Garner Engineering	High	Completed	The town has Floodplain Development Regulations in place so this action will be removed from the next update.
P-24	Floodplain Development Regulations - Town is a participating member of the National Flood Insurance Program and is considering actively participating in the Community Rating System to help monitor hazard mitigation efforts and to improve the affordability of flood insurance for citizens.	Flood	High	Garner Engineering	High	Completed	The town has Floodplain Development Regulations in place so this action will be removed from the next update.
P-25	Open Space Preservation - The Town has an existing Open Space Master Plan which identifies and evaluates various land and open space resources throughout the ETJ and Urban Service areas of the Town. The Plan has been used to develop a prioritization system that is used by all Town departments to identify properties to acquire or require as open space.	Flood	High	Garner Parks and Recreation	High	Completed	The town has an Open Space Master Plan in place so this action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-26	Unified Development Ordinance (UDO) – Existing UDO regulates development to ensure safety from fire, panic and other dangers. The UDO provides for orderly growth and development within the Town and ETJ by determining appropriate land use and development standards.	Flood, Hurricane and High winds, Tornado, Winter, Wildfire, Dam	High	Garner Planning	High	Completed	The town has a Unified Development Ordinance in place so this action will be removed from the next update.
P-27	The Town will inventory all its structures located within or immediately adjacent to known flood hazard areas.	Flood	Moderate	Garner Planning and Engineering	Moderate	2017	The Town evaluated properties in 2008 and flood insurance was purchased for properties in the floodplain. However, this inventory needs to be updated and re-evaluated to ensure proper mitigation.
P-28	The Town will seek opportunities to use Federal grant resources to assist private property owners in elevating existing structures located within flood hazard zones.	Flood	Moderate	Garner Planning and Engineering	Moderate	2019	Town pursued this but does not have a history of high flood risk properties. The town will continue to evaluate and seek funding opportunities to mitigate flood prone properties in the future.
Property Protection							
PP-1	The Town has a service to respond to requests and questions from citizens regarding actions they may take to improve drainage, halt erosion, and to relocate, renovate or retrofit structures being flooded.	Flood	Moderate	Garner Engineering	Local, Private	2015, Annual updates	The Town has a service to respond to requests and questions from citizens regarding actions they may take to improve drainage, halt erosion, and to relocate, renovate or retrofit structures being flooded. This program will be updated and reevaluated each year

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PP-2	Minimum Housing Standards Ordinance - The Town has a program which inspects existing structures to ensure that they meet the minimum housing standards. Owners of structures that do not meet these requirements will be ordered to bring the structure up to minimum standards or have the structure demolished or removed.	Flood, Hurricane and High winds, Tornado, Winter	High	Garner Inspections	Local	Completed	The town has a Minimum Housing Standards Ordinance in place so this action will be removed from the next update.
PP-3	Building Retrofit - The Town is willing to develop a plan to utilize Federal grant resources to assist private property owners in renovating and retrofitting existing structures.	Wind	Low	Garner Inspections	Local, Federal	2018	Thus far, have not had property owners to request this resource, but the town will continue to work to develop a plan to implement retrofits for future residents who so desire.
PP-4	Purchase of Open Space, Parks and Greenways – The Town works with Wake County and other agencies to find other funding for open space acquisition. Once funds are obtained the Town will acquire land consistent with Land Use and Master Open Space Plans.	Flood	Moderate	Garner Parks and Recreation	Local	Completed	The Town works with Wake County and other agencies to find other funding for open space acquisition. Once funds are obtained the Town will acquire land consistent with Land Use and Master Open Space Plans. This action has been completed so it will be removed from next update.
PP-5	Engineering Department will actively respond to flooding concerns from property owners after heavy rain events	Flood	Moderate	Garner Engineering	Local	Completed	Town response based on Town Drainage Policy. This action will be removed from the next update.
PP-6	When feasible, Town of Garner will alleviate flooding into habitable space due to storm water, as consistent with Town Drainage Policy.	Flood	Moderate	Garner Engineering, Town Council	Local	2019	Although many modifications have been made, the town will work to improve its overall stormwater drainage system going forward.
PP-7	Maintain a record of approved Letters of Map Change to continue compliance with NFIP.	Flood	Moderate	Garner Engineering	Local	Completed	The town maintains these letters and will continue to do so. This action will be removed from the next plan upate.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Natural Resource Protection							
NRP-1	The Town has adopted cluster subdivision regulations and a recreation land dedication ordinance to enhance conservation efforts.	Flood, Hurricane and High winds, Tornado, Wildfire, Winter	High	Garner Planning	Local	Completed	The Town has adopted cluster subdivision regulations and a recreation land dedication ordinance to enhance conservation efforts. This action will be removed from the next update.
NRP-2	Develop and adopt a conservation subdivision ordinance to help preserve significant natural features.	Flood, Hurricane and High winds, Tornado, Winter	Moderate	Garner Planning	Local	2017	This will become a long term goal. The Cluster Subdivision meets a majority of the criteria, but more effort will be made to preserve natural features.
NRP-3	UDO 6.1.12 – Continue to require engineered stormwater controls including stream and wetland protection.	Flood, Dam	Moderate	Garner Planning and Engineering	Local	Completed	The town's UDO is in place so this action will be removed from the next update.
NRP-4	Continue to work with the U.S. Army Corps of Engineers on wetland protection.	Flood	Moderate	Garner Planning and Engineering	Local	2018	Some efforts at wetland protection have been made over the last 5 years, but more work is necessary so the town will aim to provide more protection going forward.
NRP-5	Use Open Space Ordinance to protect wildlife habitat.	Flood, Hurricane and High winds, Tornado, Wildfire, Winter	Moderate	Garner Planning	Local	2017	The Open Space Ordinance will be utilized to protect wildlife habitat going forward even though it has not been used to a large degree in the past.
NRP-6	Continue to utilize Wake County Erosion and Sedimentation Control to ensure proper erosion control procedures are followed before and during construction.	Flood, Dam, Erosion	Moderate	Garner Planning and Engineering	Local	Completed	Wake County Erosion and Sedimentation Control has been utilized to reduce erosion and the system is in place so this action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-7	Notify Wake County of any stream dumping instances.	Flood	Moderate	Garner Engineering	Local	Completed	A system of notifying the county is in place so this action will be removed from the next update.
NRP-8	Incorporate regulations for illicit discharge control in Phase II Stormwater Management Plan.	Flood	Moderate	Garner Engineering	Local	Completed	Regulations for illicit discharge control have been integrated so this action will be removed from the next update.
NRP-9	Develop standards for tree protection and regulations governing clear cutting.	Flood, Wildfire	High	Garner Planning	Local	Completed	Standards for tree protection have been developed so this action will be removed from the next update.
NRP-10	Best Management Practices (BMPs) - The Town will include in the stormwater management plan (being developed with the Town NPDES Phase II Program) BMPs that will address both water quality and water quantity management on sites.	Flood, Dam	Moderate	Garner Engineering	Local	Completed	BMPs are the typical process for site plan approval so this action will be removed from the next update.
NRP-11	Stream Dumping – In developing the NPDES Phase II Stormwater program, the Town will design and implement an illicit discharge program which will establish regulations against stream dumping.	Flood	Low	Garner Engineering	Local	Completed	The town has developed a program that establishes regulations against stream dumping so this action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-12	Wetlands Protection - The Town has existing Riparian Buffer, Open Space, and Flood Damage Prevention ordinances that restrict development along streams and in the floodplain thus restricting development in much of the Town's wetland areas. Engineering Design Standards require that all impacts to wetlands be permitted by the U.S. Army Corps of Engineers and the NCDENR Division of Water Quality prior to issuance of a Land Disturbance Permit. The Town also has an existing program that ensures that structures, through review of the Building Permit application, are not constructed in the wetlands unless permitted by the appropriate Federal and State Agencies.	Flood	Moderate	Garner Engineering, Parks and Recreation, and Inspections	Local	Completed	The town has developed a program for wetlands protection so this action will be removed from the next update.
Structural Projects							
SP-1	Pursue stream restoration projects	Flood	High	Garner Engineering	Local, Regional, State, Federal	2019	The Town will continue to actively pursue stream restoration projects and will look for ways to expand the program through partnerships with various entities.
SP-2	Incorporate on-site retention/detention requirements for Phase II Stormwater Management Plan.	Flood	High	Garner Engineering	Local	2015	Phase II plan approved by NC Department of Environment and Natural Resources Waiting for comment period to end.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Emergency Services							
ES-1	Identify priority Town facilities and provide access to one main entrance. Restore life safety and building systems as needed.	Flood, Hurricane and High winds, Tornado, Winter	High	Garner Public Works	Local, FEMA	Completed	Town crews on standby during and after storms to clear roads and crucial Town facilities. Also, Town Hall and Police Station have standby generator for power outages. Since this system is in place, this action will be removed at the next update.
ES-2	Develop a Business Continuity Plan that is the primary document housing all disaster related plans and procedures including Hazard Mitigation Plan, Debris Management Plan, Multi-Hazard Plan as well as disaster response plans for all Town departments.	Flood, Hurricane and High winds, Tornado, Winter	High	Garner Police and Public Works	Local	2018	Town entered into a cooperative contracting agreement with the county for Disaster Debris Cleanup and monitoring in 2013. No formal disaster debris plan has been adopted.
ES-3	Emergency Operations Command Post Center – established when natural hazard imminent. Center coordinates evacuations, sheltering, staging areas for equipment, manpower, and needed supplies. Equipment includes internet access, telephone, wireless communications, radio and backup supplied by emergency batteries and/or generators.	Flood, Hurricane and High winds, Tornado, Winter, Wildfire	High	Garner Police	Local	April 2015	Plans are underway to build a new police facility that will have the capability of acting as an EOC.
ES-4	Health and safety maintenance – provide assistance with security and post storm clean-up.	Flood, Hurricane and High winds, Tornado, Winter	High	Garner Police , Public Works, and EMS	Local	Completed	The town has a system in place to maintain health and safety post-storm so this action will be removed from next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-5	Post disaster response – building inspections. Inspector team does post disaster damage assessment using FEMA guidelines.	Flood, Hurricane and High winds, Tornado, Winter	Moderate	Garner Inspections	Local	Completed	Inspector team does post disaster damage assessment using FEMA guidelines. This action will be removed from next update.
ES-6	Continue to evaluate and improve response and recovery methods following each hazard event.	Flood, Hurricane and High winds, Tornado, Winter, Wildfire	High	Garner Police	Local	Completed	The town will review and update its response and recovery methods after each hazard event. This action will be removed from next update.
ES-7	Tracking of Known Drainage, Erosion and Flooding Problems - The Town has a current program to track drainage complaints, flooding and erosion problems within the town limits and ETJ.	Flood	Moderate	Garner Engineering	Local	Completed	The Town has a current program to track drainage complaints, flooding and erosion problems within the town limits and ETJ. This action will be removed from next update.
ES-8	Mobile Command Post - Available 24 hours a day and equipped to communicate with all agencies in the Triangle including Emergency Management, State agencies, fire departments, etc. The Town will be upgrading this service.	All Hazards	High	Garner Police	Local, State	2018	Available 24 hours a day and equipped to communicate with all agencies in the Triangle including Emergency Management, State agencies, fire departments, etc. The Town will be upgrading this service. Add to Town's CIP for future funding.
Public Education and Awareness							
PEA-1	Stormwater staff provides flood information through calling or e-mail program to any inquirer. County requires that flood zone information be shown on all plats recorded within the Town planning jurisdiction.	Flood	High	Garner Engineering	Local	Completed	Stormwater staff provides flood information through calling or e-mail program to any inquirer. County requires that flood zone information be shown on all plats recorded within the Town planning jurisdiction. This action will be removed from next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-2	Town website will be updated to answer citizen questions about flood hazards, flood safety, availability of flood insurance, stormwater regulations, and other information.	Flood	Moderate	Garner Engineering	Local	2015	Engineering department will add storm water and floodplain information to the website
PEA-3	Town website will be updated with public access to information pertaining to evacuation routes, emergency contact numbers, and detailed weather reports in case of emergency.	Flood, Hurricane and High winds, Tornado, Winter, Wildfire	Moderate	Garner Computer Information Services	Local	2015	Since this activity is headed by Wake County Emergency Management, the Town will include a link on its website.
PEA-4	Continue to update flood hazard maps to reflect new subdivisions, changes in corporate limits, and any new DFIRM data as provided by the County.	Flood	Moderate	Garner Engineering and Planning	Local	Completed	Flood plain maps updated. Garner saw little to no change in base flood elevations
PEA-5	Planned park land purchase – nature park to include trails and environmental education center.	Flood	High	Garner Parks and Recreation, POSE	Local, Wake County, State Grant	Completed	Town completed development of White Deer Park in October 2009. It has a LEED certified Nature Center that focuses on environmental education. It preserves open space and has several BMPs for water quality and quantity.
PEA-6	Maintain floodplain maps for public use and produce other maps as needed.	Flood	Moderate	Garner Engineering	Local	Completed	The town has floodplain maps and other maps showing flood risk. This action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-7	Develop and maintain a hazard mitigation section on the Town website.	All Hazards	Moderate	Garner Administration and Computer Information Services	Local	2015	The Town website was recently redesigned and a hazard mitigation section was not included. However, the Hazard Mitigation Plan has been posted on the Town website. A separate section will be created and information added.
PEA-8	Collect educational materials on disaster preparedness and display at public library and local government offices.	Flood, Hurricane and High winds, Tornado, Winter, Dam	High	Garner Administration	Local	Completed	The Town posts the "Ready Wake" brochures created by Wake County in Town Hall buildings during hurricane season so this action will be removed from the next update.
PEA-9	Map Information - The Town maintains current FIRM maps/studies for Town limits and ETJ. Town also maintains current land use, structure, and development maps. All maps are available for public use.	Flood, Wildfire	High	Garner Engineering and Planning	Local	Completed	The Town maintains current FIRM maps/studies for Town limits and ETJ. Town also maintains current land use, structure, and development maps. All maps are available for public use.
PEA-10	Website - The Town maintains its own website which is able to provide up to date information for the public. Town continuously updates the site with additional resources.	All Hazards	High	Garner Town Council, Computer Information Services, All Departments	Local	2018	The Town website was recently redesigned. Going forward, more information will be included on reducing damage and mitigation.
PEA-11	Website- Create link to Wake County Hazard Mitigation Plan.	All Hazards	Moderate	Garner Computer Information Services	Local	Deleted	Combine with PEA-7

Annex E
Town of Holly Springs

This annex includes jurisdiction-specific information for the Town of Holly Springs. It consists of the following five subsections:

- E.1 Town of Holly Springs Community Profile
- E.2 Town of Holly Springs Risk Assessment
- E.3 Town of Holly Springs Vulnerability Assessment
- E.4 Town of Holly Springs Capability Assessment
- E.5 Town of Holly Springs Mitigation Strategy

E.1 TOWN OF HOLLY SPRINGS COMMUNITY PROFILE

E.1.1 Geography and the Environment

Holly Springs is town located in Wake County in the state of North Carolina. It initially grew around the fresh water springs that are located in the town and it has experienced extensive growth in the past 20 to 30 years.

Overall, Wake County is known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Summer temperatures generally venture into the 90s for highs and cool off to the 70s at night. Winter temperatures in can drop to below freezing but generally highs are in the 50s. Rainfall is most common in the summer months but occurs consistently throughout the year.

E.1.2 Population and Demographics

According to the 2010 Census, Holly Springs has a population of 24,661 people. The jurisdiction has seen exceptional growth between 2000 and 2010, and the population density is almost 1,700 people per square mile. Population counts from the US Census Bureau for 1990, 2000, and 2010 are presented in **Table E.1**.

TABLE E.1: POPULATION COUNTS FOR HOLLY SPRINGS

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
HOLLY SPRINGS	908	9,192	24,661	168.29%

Source: US Census Bureau

The racial characteristics of the jurisdiction are presented in **Table E.2**. Whites make up the majority of the population in the jurisdiction, accounting for nearly 80 percent of the population.

TABLE E.2: DEMOGRAPHICS OF HOLLY SPRINGS

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
HOLLY SPRINGS	79.8%	12.6%	0.4%	7.2%	5.8%

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

E.1.3 Housing

According to the 2010 US Census, there are 8,656 housing units in Holly Springs, the majority of which are single family homes or mobile homes. Housing information for the jurisdiction is presented in **Table E.3**.

TABLE E.3: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Seasonal Units, Percent (2010)	Median Home Value (2006-2010)
HOLLY SPRINGS	3,642	8,658	5.9%	$236,700

Source: US Census Bureau

E.1.4 Infrastructure

Transportation
There are several major roadways that residents of Holly Springs utilize. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs, one of which is I-540/NC-540 which is a partly completed loop that connects the jurisdiction to many of the other municipalities. In addition to the Interstate, there are many major highways that residents of the municipality utilize. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways in the include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities
Electrical power in the jurisdiction is provided by two entities and Duke Energy and Wake Electric Membership Corporation with Duke Energy providing service to a majority of the service. Water and sewer service is provided by two main entities as well: The City of Raleigh Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

Community Facilities

There are a number of buildings and community facilities located throughout Holly Springs. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 2 police stations and 5 public schools located within the county.

Citizens also have access to several parks, including three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the county, including the American Tobacco Trail which is a rails to trails project that is open to a wide variety of non-motorized uses.

E.1.5 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land as parks. There are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the jurisdiction consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

E.1.6 Employment and Industry

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

E.2 TOWN OF HOLLY SPRINGS RISK ASSESSMENT

This subsection includes hazard profiles for each of the significant hazards identified in Section 4: *Hazard Identification* as they pertain to Holly Springs. Each hazard profile includes a description of the hazard's location and extent, notable historical occurrences, and the probability of future occurrences. Additional information can be found in Section 5: *Hazard Profiles*.

E.2.1 Drought

Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, Holly Springs has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that the county would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Historical Occurrences

According to the North Carolina Drought Monitor, Holly Springs has had drought occurrences all of the last fourteen years (2000-2013). **Table E.4** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE E.4: HISTORICAL DROUGHT OCCURRENCES IN HOLLY SPRINGS

Abnormally Dry **Moderate Drought** **Severe Drought** **Extreme Drought** **Exceptional Drought**

	Holly Springs
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that Holly Springs has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

E.2.2 Extreme Heat

Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to any geographic or political boundaries. All of Holly Springs is susceptible to extreme heat conditions.

Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Holly Springs. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the region. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the county. The most centralized location is in Raleigh at North Carolina State University. **Table E.5** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table E.5: Average Maximum Temperature in Raleigh, Wake County

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

Probability of Future Occurrences
Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

E.2.3 Hailstorm

Location and Spatial Extent
Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Holly Springs is uniformly exposed to severe thunderstorms; therefore, all areas are equally exposed to hail which may be produced by such storms.

Historical Occurrences
According to the National Climatic Data Center, 7 recorded hailstorm events have affected Holly Springs since 1993.[1] **Table E.6** is a summary of the hail events in Holly Springs. **Table E.7** provides detailed information about each event that occurred. In all, hail occurrences resulted in $0 (2013 dollars) in property damages. Hail ranged in diameter from 0.75 inches to 1.75 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value.

Table E.6: Summary of Hail Occurrences in Holly Springs

Location	Number of Occurrences	Property Damage (2013)
Holly Springs	7	$0

[1] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Holly Springs. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

Location	Number of Occurrences	Property Damage (2013)

Source: National Climatic Data Center

TABLE E.7: HISTORICAL HAIL OCCURRENCES IN HOLLY SPRINGS

	Date	Magnitude	Deaths/Injuries	Property Damage*
Holly Springs				
HOLLY SPGS	6/3/2000	0.75 in.	0/0	$0
HOLLY SPGS	6/1/2001	0.75 in.	0/0	$0
HOLLY SPGS	5/29/2007	1 in.	0/0	$0
HOLLY SPGS	4/27/2008	0.75 in.	0/0	$0
HOLLY SPGS	5/9/2008	0.75 in.	0/0	$0
HOLLY SPGS	5/20/2008	1.75 in.	0/0	$0
HOLLY SPGS	5/23/2012	0.88 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that Holly Springs has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the county.

E.2.4 Hurricane and Tropical Storm

Location and Spatial Extent

Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Holly Springs. The entire jurisdiction is equally susceptible to hurricane and tropical storms.

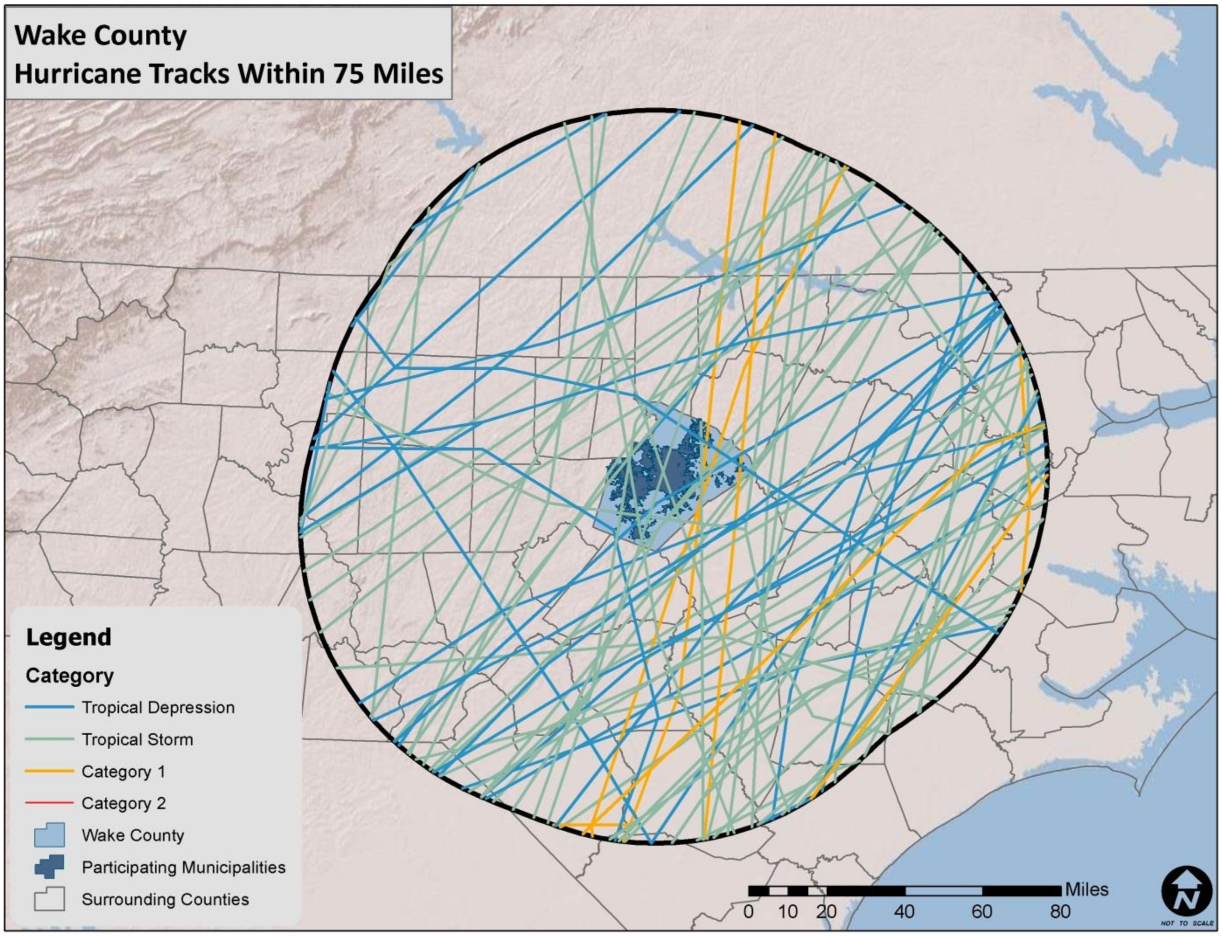
Historical Occurrences

According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[2] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms have traversed directly through Wake County as shown in **Figure E.1**. **Table E.8** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

[2] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

FIGURE E.1: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE E.8: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1
1882	NOT NAMED	53	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm
1959	CINDY	26	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression
2008	HANNA	40	Tropical Storm

Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Holly Springs between 1950 and 2013. These storms are listed in **Table E.9** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE E.9: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made in 1996 (Hurricane Fran), 1999 (Hurricane Floyd), and 2003 (Hurricane Isabel) for the county.[3]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Tropical Storm Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

Probability of Future Occurrences
Given the inland location of the jurisdiction, it is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Holly Springs. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the jurisdiction is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

[3] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

E.2.5 Lightning

Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Holly Springs is uniformly exposed to lightning.

Historical Occurrences

According to the National Climatic Data Center, there have been two recorded lightning events in Holly Springs since 1950, as listed in summary **Table E.10** and detailed in **Table E.11**.[4] However, it is certain that more lightning events have in fact impacted the jurisdiction. Many of the reported events are those that caused damage, and it should be expected that damages are likely much higher for this hazard than what is reported.

TABLE E.10: SUMMARY OF LIGHTNING OCCURRENCES IN HOLLY SPRINGS

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Holly Springs	2	0/0	$1,463,162

Source: National Climatic Data Center

TABLE E.11: HISTORICAL LIGHTNING OCCURRENCES IN HOLLY SPRINGS

	Date	Deaths/Injuries	Property Damage*	Details
Holly Springs				
HOLLY SPGS	7/29/2010	0/0	$337,653	A line of strong to severe storms formed as a cold front moved into a very moist and moderately unstable air mass.
HOLLY SPGS	6/2/2010	0/0	$1,125,509	Strong to severe slow moving storms and merging storms resulted in severe damaging winds and flash flooding across portions of Central North Carolina. Frequent to excessive lightning resulted in property damage across the area to homes and businesses.

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Although there were not a high number of historical lightning events reported in Holly Springs via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S.

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Holly Springs. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

National Lightning Detection Network (NLDN®), Holly Springs is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the jurisdiction.

E.2.6 Severe Thunderstorm/High Wind

Location and Spatial Extent

A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Also, Holly Springs typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Holly Springs has uniform exposure to an event and the spatial extent of an impact could be large.

Historical Occurrences

Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011.[5] According to NCDC, there have been 13 reported thunderstorm/high wind events since 1994 for high wind and since 1950 for thunderstorms.[6] These events caused over $119,000 (2013 dollars) in damages. **Table E.12** summarizes this information. **Table E.13** presents detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event.[7]

TABLE E. 12: SUMMARY OF THUNDERSTORM/HIGH WIND OCCURRENCES IN HOLLY SPRINGS

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Holly Springs	13	0/0	$119,110

Source: National Climatic Data Center

TABLE E.13: HISTORICAL THUNDERSTORM/HIGH WIND OCCURRENCES IN HOLLY SPRINGS

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Holly Springs					
Holly Springs	8/17/1994	THUNDERSTORM WINDS	56 kts.	0/0	$0
HOLLY SPGS	6/3/1998	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	3/3/1999	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	5/13/2002	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	4/25/2006	TSTM WIND	51 kts.	0/0	$0

[5] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional thunderstorm events have occurred in Holly Springs. As additional local data becomes available, this hazard profile will be amended.
[7] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
HOLLY SPGS	4/25/2006	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	4/25/2006	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	4/25/2006	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	6/11/2006	TSTM WIND	50 kts.	0/0	$0
HOLLY SPGS	7/11/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
HOLLY SPGS	7/31/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
HOLLY SPGS	7/31/2009	THUNDERSTORM WIND	50 kts.	0/0	$115,927
HOLLY SPGS	7/9/2012	THUNDERSTORM WIND	50 kts.	0/0	$3,183

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire jurisdiction.

E.2.7 Tornado

Location and Spatial Extent

Tornadoes occur throughout the state of North Carolina, and thus in Holly Springs. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Holly Springs is uniformly exposed to this hazard.

Historical Occurrences

Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there has been one recorded tornado events in Holly Springs since 1956 (**Table E.14**), resulting in $0 (2013 dollars) in property damages.[8] Detailed information on these events can be found in **Table E.15**. It is important to note that only tornadoes that have been reported are factored into this risk assessment and an F5 magnitude tornado is possible. It is likely that a high number of occurrences have gone unreported over the past 50 years.

TABLE E.14: SUMMARY OF TORNADO OCCURRENCES IN HOLLY SPRINGS

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Holly Springs	1	0/0	$0

Source: National Climatic Data Center

[8] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Holly Springs. As additional local data becomes available, this hazard profile will be amended.

TABLE E.15: HISTORICAL TORNADO IMPACTS IN HOLLY SPRINGS

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Holly Springs					
Holly Springs	3/20/1998	F0	0/0	$0	A home video of this storm showed a wall cloud with several small vortices. One of these touched down very briefly and damaged the roof of one home. The adjacent homes, and there were many, were untouched. The insulation from the home was then spread into adjacent trees

*Property Damage is reported in 2013 dollars.
Source: NCDC

2011 Tornadoes- April 16, 2011
In 2011, the county and all of its jurisdictions were impacted by one of the worst tornado-related events in the county's recorded history. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries.

Probability of Future Occurrences
According to historical information, tornado events are not an annual occurrence for the jurisdiction. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Holly Springs experience a direct tornado strike. The probability of future tornado occurrences affecting Holly Springs is likely (10-100 percent annual probability).

E.2.8 Winter Storm and Freeze

Location and Spatial Extent
Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Holly Springs is accustomed to smaller scale severe winter weather conditions and often receives severe winter weather during the winter months. Given the atmospheric nature of the hazard, the entire jurisdiction has uniform exposure to a winter storm.

Historical Occurrences
Severe winter weather has resulted in six disaster declarations in Holly Springs. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. [9] According to the National Climatic Data Center, there have been no recorded winter storm events in Holly Springs

[9] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.

since 1993 (**Table E.16**).[10] These events resulted in $0 (2013 dollars) in damages. However, there have been 28 recorded countywide events and most severe winter weather events are only recorded at the county level.

TABLE E.16: SUMMARY OF WINTER STORM EVENTS IN HOLLY SPRINGS

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Holly Springs	0	0/0	$0

Source: National Climatic Data Center

There have been several severe winter weather events in Holly Springs. The text below describes one of the major events and associated impacts on the county. Similar impacted can be expected with severe winter weather.

1996 Winter Storm
This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and power outages. Furthermore, citizens may resort to using inappropriate heating devices that could to fire or an accumulation of toxic fumes.

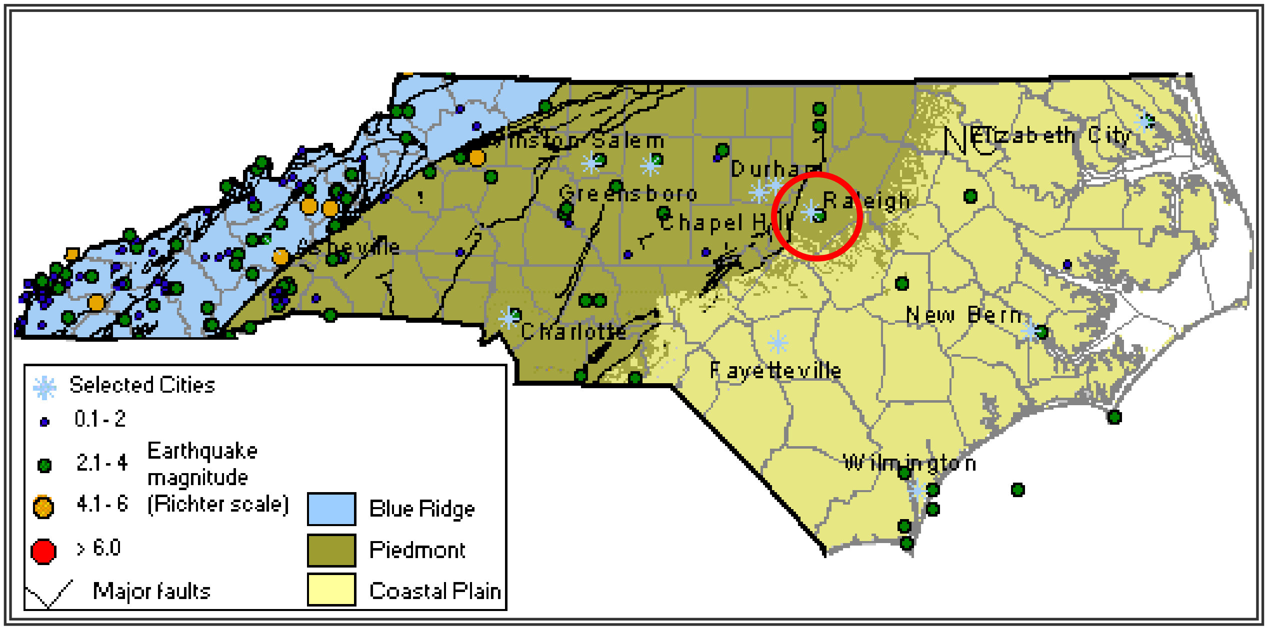
Probability of Future Occurrences
Winter storm events will remain a somewhat regular occurrence in Holly Springs due to location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

E.2.9 Earthquake

Location and Spatial Extent
Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina. **Figure E.2** is a map showing geological and seismic information for North Carolina.

[10] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional winter storm conditions have affected Holly Springs.

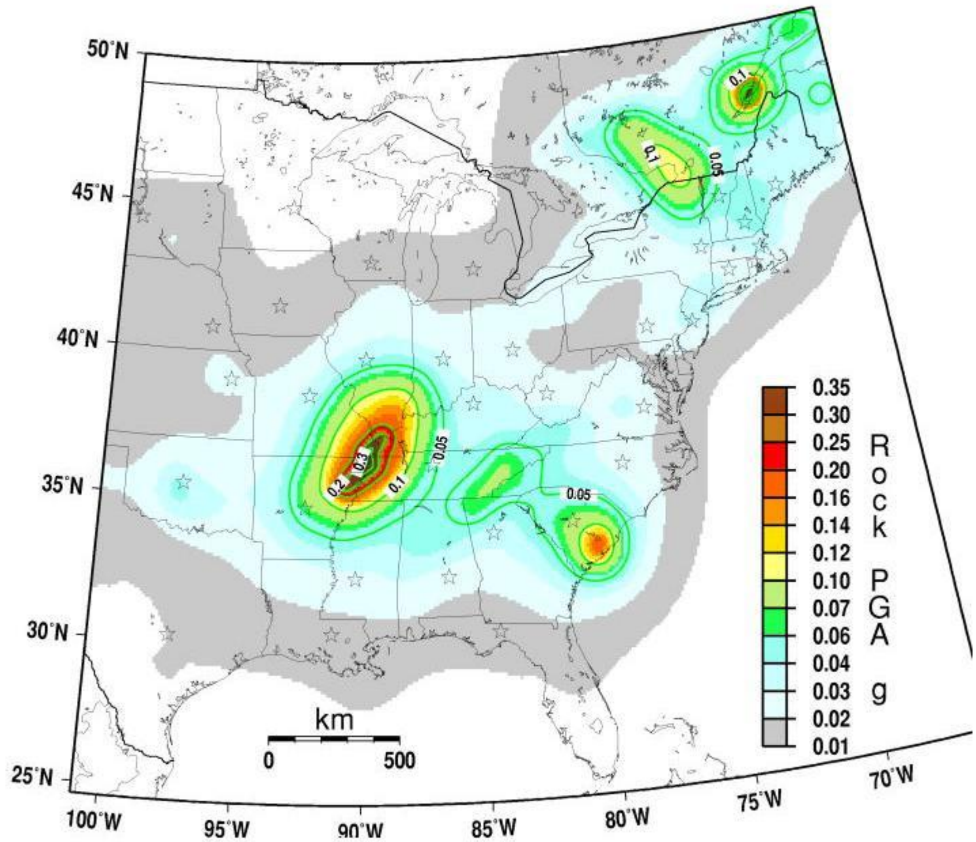
FIGURE E.2: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure E.3 shows the intensity level associated with Holly Springs, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Holly Springs lies within an approximate zone of level "2" to "3" ground acceleration. This indicates that the county exists within an area of moderate seismic risk.

FIGURE E.3: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

Historical Occurrences

Although no earthquakes are known to have occurred directly in Holly Springs since 1874, several have occurred in the county and affected the municipality. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table E.17** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table E.18** presents a detailed occurrence of each event including the date, distance for the epicenter, and Modified Mercalli Intensity (if known). [11]

TABLE E.17: SUMMARY OF SEISMIC ACTIVITY IN HOLLY SPRINGS

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Holly Springs	--	--	--

Source: National Geophysical Data Center

[11] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

TABLE E.18: SIGNIFICANT SEISMIC EVENTS IN HOLLY SPRINGS (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI (magnitude)
Holly Springs				
None reported				

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Holly Springs, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table E.19.**

TABLE E.19: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 - 1	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928*	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957*	Buncombe County, NC	3.7	VI	VI
11/24/1957*	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973*	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Holly Springs occurrences.
** Conflicting reports on this event, intensity in North Carolina could have been either V or VI
Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Holly Springs is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. The annual probability level for the county is estimated between 1 and 10 percent (possible).

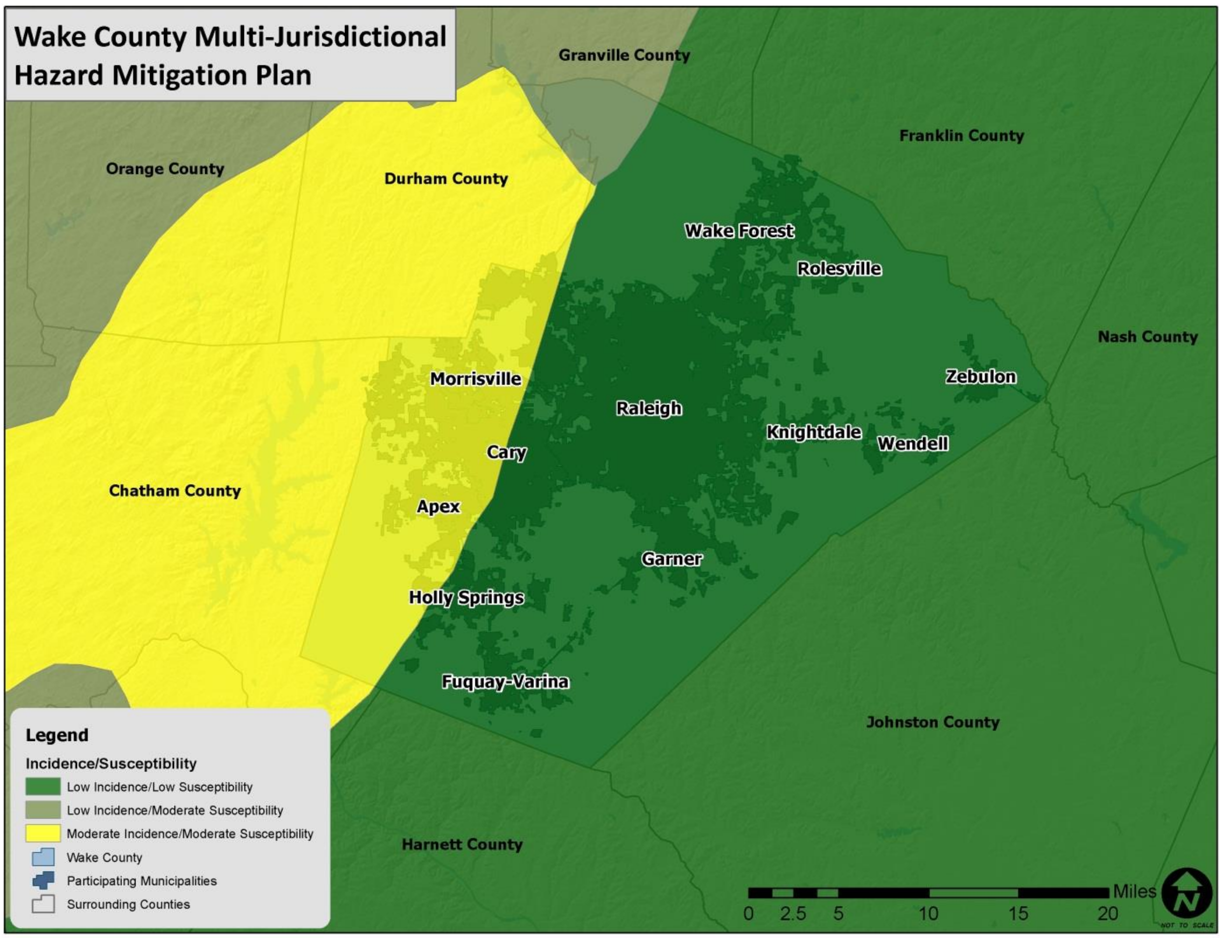
E.2.10 Landslide

Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Holly Springs, although the overall risk is relatively low.

According to **Figure E.4** below, the majority of the county has low landslide activity. However there is a small area along the western border of the county (which includes parts of Holly Springs) that has a moderate incidence and moderate susceptibility. In all other areas, there is low susceptibility.

FIGURE E.4: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

Historical Occurrences

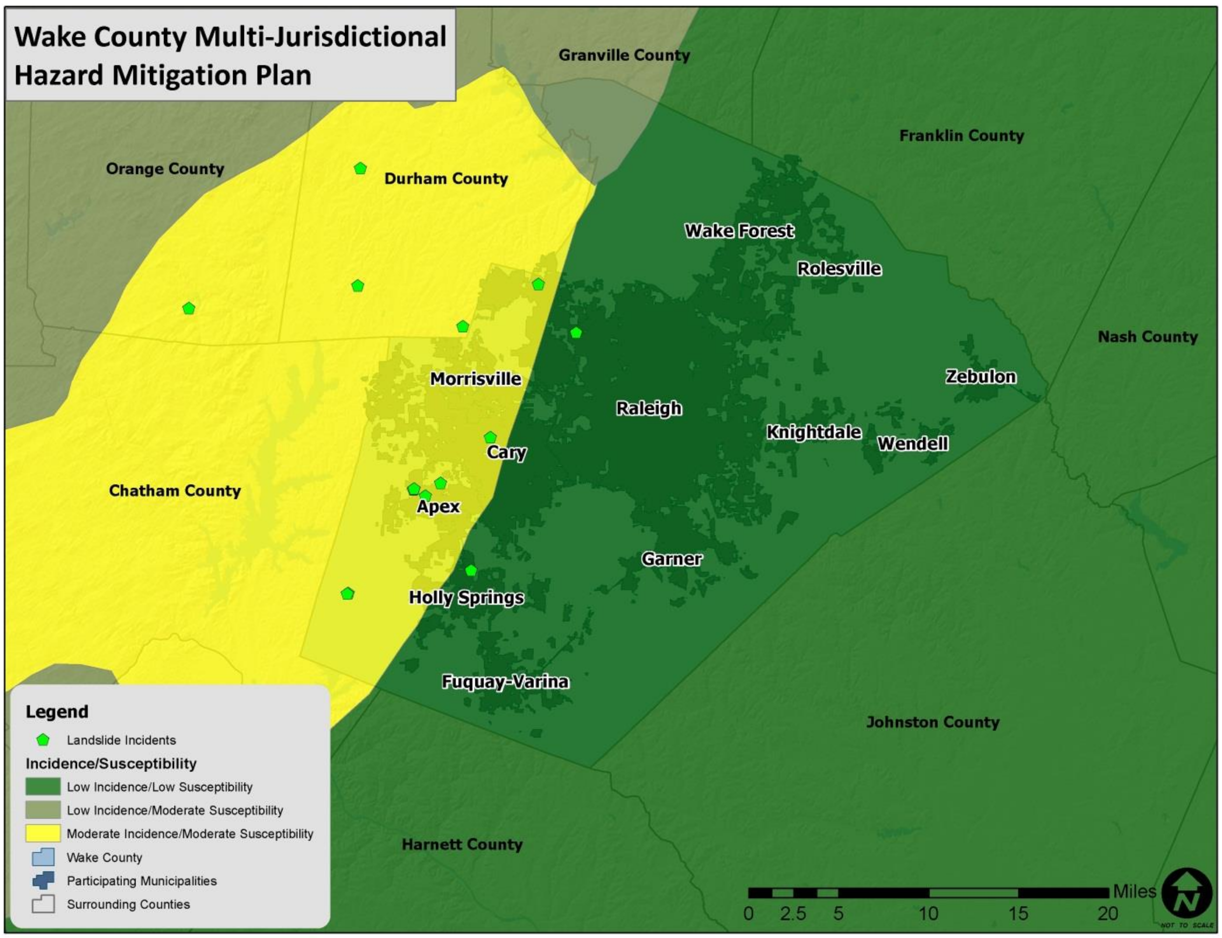
Steeper topography in some areas of Holly Springs make the planning area susceptible to landslides. Most landslides are caused by heavy rainfall in the area. Building on steep slopes that was not previously possible also contributes to risk. **Table E.20** presents a summary of the landslide occurrence events as provided by the North Carolina Geological Survey[12]. The georeferenced locations of the landslide events presented in the aforementioned tables are presented in **Figure E.5**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred in Holly Springs.

TABLE E.20: SUMMARY OF LANDSLIDE ACTIVITY IN HOLLY SPRINGS

Location	Number of Occurrences
Holly Springs	1

Source: North Carolina Geological Survey

FIGURE E.5: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for

[12] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Holly Springs have greater risk than others given factors such as steepness on slope and modification of slopes.

E.2.11 Dam and Levee Failure

Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table E.21** explains these classifications.

TABLE E.21: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

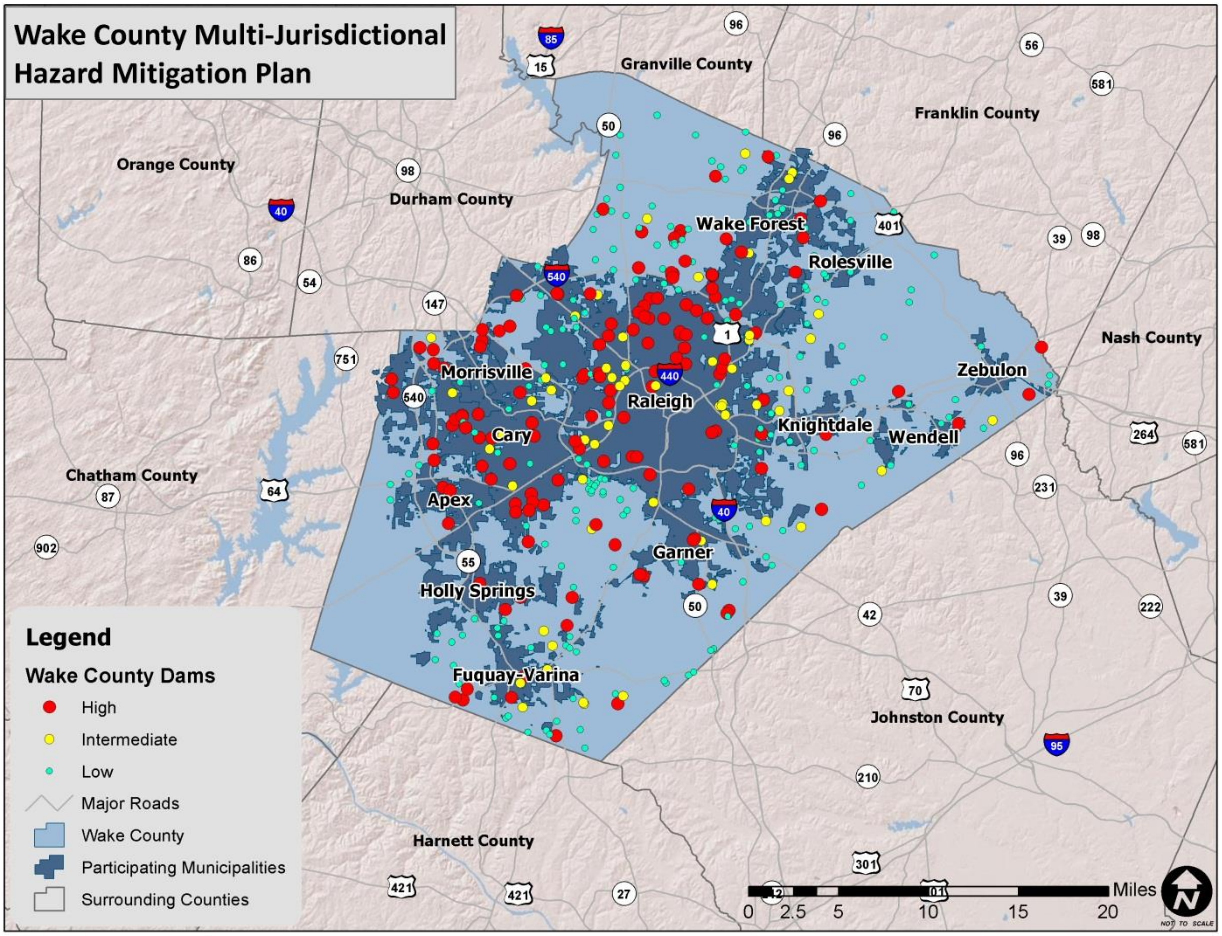
Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

According to the North Carolina Division of Land Management there are 2 dams in Holly Springs.[13] **Figure E.6** shows the dam location and the corresponding hazard ranking for each. Of these dams, two are classified as high hazard potential. These high hazard dams are listed in **Table E.22**.

[13] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE E.6: WAKE COUNTY DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE E.22: HOLLY SPRINGS HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Holly Springs				
Bass Lake Dam	High	58.6	910	Local Gov
Windcrest	High	4.2	42	Local Gov

Source: North Carolina Division of Land Resources, 2012

It should also be noted that the North Carolina dam classification regulations were recently updated. As a result of the change, more dams are generally classified as high hazard.

Historical Occurrences

One dam breach was reported in Holly Springs during Hurricane Fran in 1996 at Bass Lake Dam.

Probability of Future Occurrences

Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

E.2.12 Erosion

Location and Spatial Extent

Erosion in Holly Springs is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Holly Springs soils have greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Holly Springs, particularly along the banks of rivers and streams, but it is not an extreme threat. No areas of concern were reported by the planning committee.

Historical Occurrences

Several sources were vetted to identify areas of erosion in Holly Springs. This includes searching local newspapers, interviewing local officials, and reviewing the previous hazard mitigation plan. Little information could be found and erosion was not addressed in the previous Holly Springs hazard mitigation plan.

Probability of Future Occurrences

Erosion remains a natural, dynamic, and continuous process for Holly Springs, and it will continue to occur. The annual probability level assigned for erosion is possible (between 1 and 10 percent annually).

E.2.13 Flood

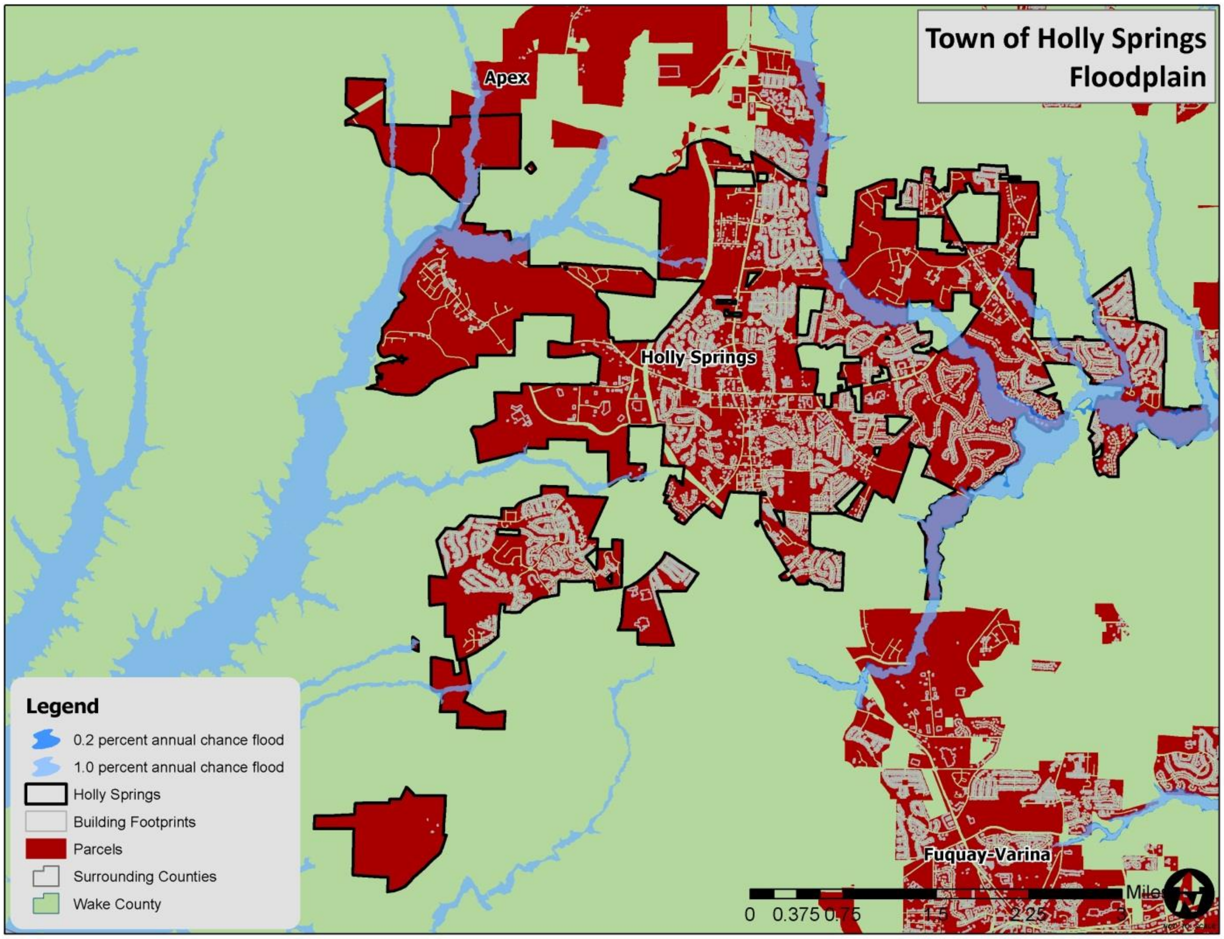
Location and Spatial Extent

There are areas in Holly Springs that are susceptible to flood events. Special flood hazard areas in the jurisdiction were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[14] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 15 square miles that make up Holly Springs, there are 0.98 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain).

These flood zone values account for 6.5 percent of the total land area in Holly Springs. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas. **Figure E.7** illustrates the location and extent of currently mapped special flood hazard areas for Holly Springs based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.

[14] The county-level DFIRM data used for Holly Springs were updated in 2010.

FIGURE E.7: SPECIAL FLOOD HAZARD AREAS IN HOLLY SPRINGS



Source: Federal Emergency Management Agency

Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported a total of 1 event in Holly Springs since 1993.[15] A summary of these events is presented in **Table E.23**. These events accounted for $0 (2013 dollars) in property damage in the jurisdiction.[16] Specific information on flood events, including date, type of flooding, and deaths and injuries, can be found in **Table E.24**.

TABLE E.23: SUMMARY OF FLOOD OCCURRENCES IN HOLLY SPRINGS

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Holly Springs	1	0/0	$0

Source: National Climatic Data Center

[15] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.

[16] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

TABLE E.24: HISTORICAL FLOOD EVENTS IN HOLLY SPRINGS

	Date	Type	Deaths/ Injuries	Property Damage*
Holly Springs				
Holly Springs	8/11/2001	FLASH FLOOD	0/0	$0

Source: National Climatic Data Center

Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there have been 3 flood losses reported in Holly Springs through the National Flood Insurance Program (NFIP) since 1978. A summary of these figures for the jurisdiction is provided in **Table E.25**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that additional instances of flood loss in Holly Springs were either uninsured, denied claims payment, or not reported.

TABLE E.25: SUMMARY OF INSURED FLOOD LOSSES IN HOLLY SPRINGS

Location	Flood Losses	Claims Payments
Holly Springs	3	$32,312

Source: FEMA, NFIP

Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

As of July 2013, there are 0 non-mitigated repetitive loss properties located in Holly Springs, which accounted for 0 losses and $0 in claims payments under the NFIP. Without mitigation, repetitive loss properties will likely continue to experience flood losses. **Table E.26** presents detailed information on repetitive loss properties and NFIP claims and policies for Holly Springs.

TABLE E.26: SUMMARY OF REPETITIVE LOSS PROPERTIES IN HOLLY SPRINGS

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Holly Springs	0	-	0	$0	$0	$0	$0

Source: National Flood Insurance Program

Probability of Future Occurrences

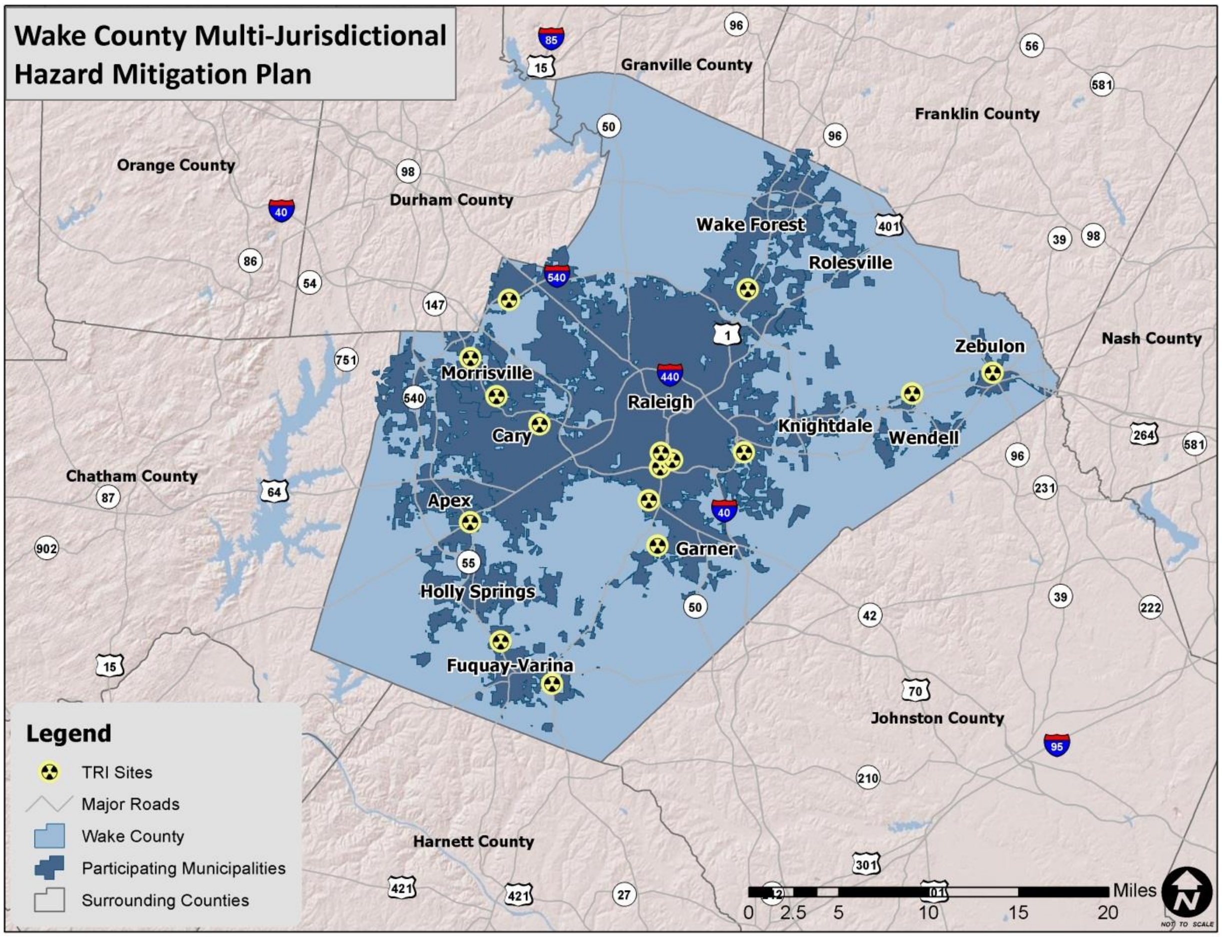
Flood events will remain a threat in areas prone to flooding in Holly Springs, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability) The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above**,** which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

E.2.14 Hazardous Materials Incidents

Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Holly Springs has no TRI sites as shown in **Figure E.8.**

FIGURE E.8: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the jurisdiction via roadways and rail. All roads that permit hazardous material transport are considered potentially at risk to an incident.

Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table E.27 presents detailed information on historic HAZMAT incidents reported in Holly Springs.

TABLE E.27: SUMMARY OF HAZMAT INCIDENTS IN HOLLY SPRINGS

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Holly Springs							
None reported							

Source: USDOT PHMSA

Probability of Future Occurrences

Although there are no toxic release inventory sites in Holly Springs, there are several roadways and rails that transport hazardous materials, so it is possible that a hazardous material incident may occur in the jurisdiction (between 1 percent and 10 percent annual probability). Local officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

E.2.15 Wildfire

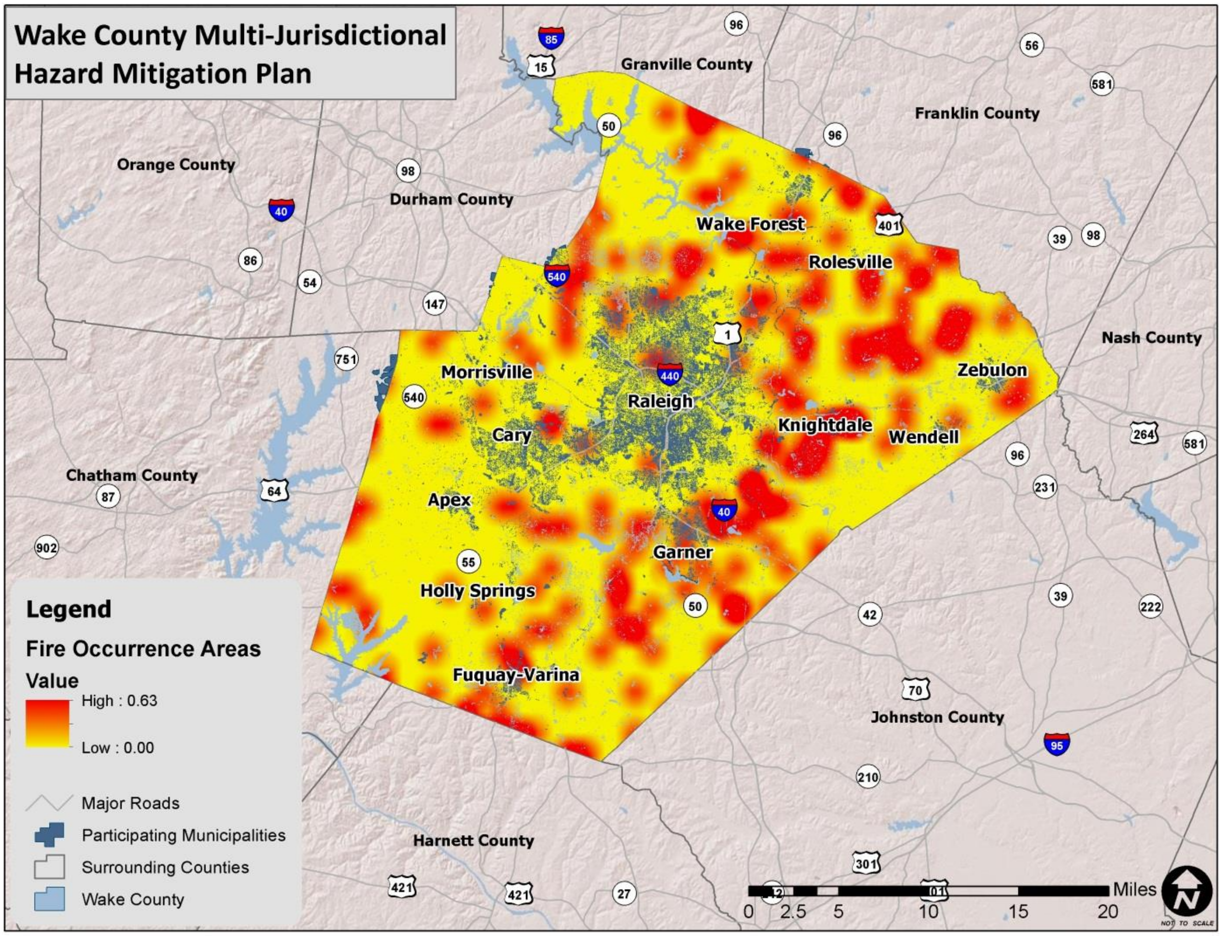
Location and Spatial Extent

The entire jurisdiction is at some risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas.

Historical Occurrences

Figure E.9 shows the Fire Occurrence Areas (FOA) in Holly Springs based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. Therefore, even areas classified as at relatively high risk within the county are a relatively low risk compared to other areas of the state.

FIGURE E.9: HISTORIC WILDFIRE EVENTS IN HOLLY SPRINGS



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of 16 wildfires annually which burn an average of 98 acres per year. The data indicates that most of these fires are small, averaging six acres per fire. **Table E.28** lists the number of reported wildfire occurrences in the county between the years 2003 and 2012.

TABLE E.28: HISTORICAL WILDFIRE OCCURRENCES IN HOLLY SPRINGS

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Holly Springs. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Holly Springs for future wildfire events is possible (a 1 and 10 percent annual probability).

E.2.16 Nuclear Accident

Location and Spatial Extent

The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station.

Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 “Alerts” and 28 “Notice of Unusual Events” since 1986, which are shown in **Table E.29**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table E.29: SHEARON HARRIS EMERGENCY DECLARATION HISTORY

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on “B” Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).

Emergency Declaration	Date	Description
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of "A" Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - "B" diesel generator was being worked on; in accordance with test procedures, "A" diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported "Notice of Unusual Events" since 1986, which is shown in **Table E.30**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table E.30: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Probability of Future Occurrences

A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

E.2.17 Terror Threat

Location and Spatial Extent

A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table E.31** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

TABLE E.31 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food	▪ Government Facilities
▪ Banking and Finance	▪ Healthcare and Public Health
▪ Chemical	▪ Information Technology
▪ Commercial Facilities	▪ National Monuments and Icons
▪ Communications	▪ Nuclear Reactors, Materials, and Waste
▪ Critical Manufacturing	▪ Postal and Shipping
▪ Dams	▪ Transportation Systems
▪ Defense Industrial Base	▪ Water
▪ Emergency Services	
▪ Energy	

Historical Occurrences

Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

Probability of Future Occurrences

Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

E.2.18 Conclusions on Hazard Risk

The hazard profiles presented above were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and

experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

Hazard Extent

Table E.32 describes the extent of each natural hazard identified for Holly Springs. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE E.32 EXTENT OF HOLLY SPRINGS HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page E:4). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Holly Springs has received this ranking three times over the fourteen year reporting period.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Holly Springs was 1.75 inches. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), Holly Springs is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Thunderstorm Wind/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Holly Springs was reported at 56 knots (approximately 64 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). The greatest magnitude reported was an F0 (reported on March 20, 1998).
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Holly Springs. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is between low and moderate in Holly Springs. There is also moderate susceptibility in some areas.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). Of the 2 dams in Holly Springs, 2 are classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records located in Holly Springs.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 6.5 percent of the total land area in Holly Springs. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second.
Other Hazards	
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incident reported in the region is 75 LGA released on the highway in Raleigh. It should be noted that larger events are possible.
Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).

Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

Priority Risk Index Results

In order to draw some meaningful planning conclusions on hazard risk for Holly Springs, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). More information on the PRI and how it was calculated can be found in Section 5.20.2.

Table E.33 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups and Coordinating Committee. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE E.33: SUMMARY OF PRI RESULTS FOR HOLLY SPRINGS

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	2.5
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	2.4
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	2.5
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	2.9
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	2.1
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	3.1
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	2.7
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	2.5
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	2
Landslide	Possible	Minor	Small	Less than 6 hours	Less than 6 hours	1.8
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	2.1
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	1.8
Flood	Likely	Critical	Small	6 to 12 hours	Less than 1 week	2.8
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	2.5
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	2
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	2.6
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	2.4

E.2.16 Final Determinations on Hazard Risk

The conclusions drawn from the hazard profiling process for Holly Springs, including the PRI results and input from the Regional Work Groups and Coordinating Committee, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table E.34**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Holly Springs. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment* and below in Section E.3. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE E.34: CONCLUSIONS ON HAZARD RISK FOR HOLLY SPRINGS

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Nuclear Accident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

E.3 TOWN OF HOLLY SPRINGS VULNERABILITY ASSESSMENT

This subsection identifies and quantifies the vulnerability of Holly Springs to the significant hazards previously identified. This includes identifying and characterizing an inventory of assets in the county and assessing the potential impact and expected amount of damages caused to these assets by each identified hazard event. More information on the methodology and data sources used to conduct this assessment can be found in Section 6: *Vulnerability Assessment*.

E.3.1 Asset Inventory

Table E.35 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for Holly Springs (study area of vulnerability assessment).[17]

TABLE E.35: IMPROVED PROPERTY IN HOLLY SPRINGS

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Holly Springs	10,253	$2,614,443,181	8,162	$1,967,125,463

Table E.36 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in Holly Springs. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. In addition, a list of secondary facilities was created to recognize the importance of these facilities in the event of a disaster. These facilities were not mapped, but it is important to recognize that they could be potentially impacted by nearly any of the identified hazards, especially those that are atmospheric or have no specific spatial delineation.

All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure E.10** shows the locations of the primary critical facilities in Wake County. **Table E.48**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility. As noted previously, this list is not all-inclusive and only includes information provided by the local government.

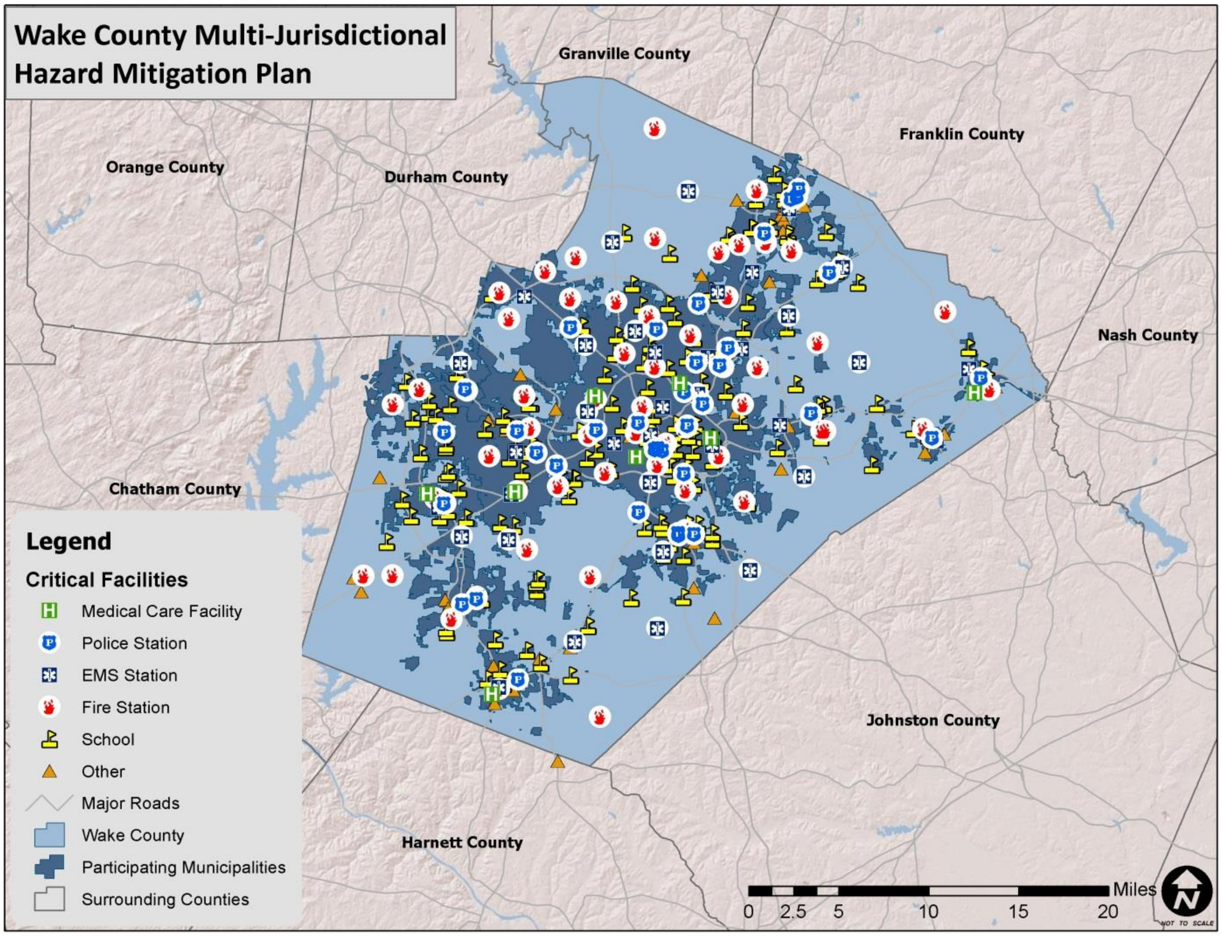
TABLE E.36: CRITICAL FACILITY INVENTORY IN HOLLY SPRINGS

Location	Fire Stations	Police Stations	Medical Care Facilities	EOC	Schools	Other
Holly Springs	0	2	0	0	5	3

Source: Local Governments

[17] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

FIGURE E.10: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: Local Governments

E.3.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Holly Springs that are potentially at risk to these hazards.

Table E.37 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, limited the results to county-wide estimates. The total population in Holly Springs according to Census data is 24,661 persons. Additional population estimates are presented above in Section E.1.

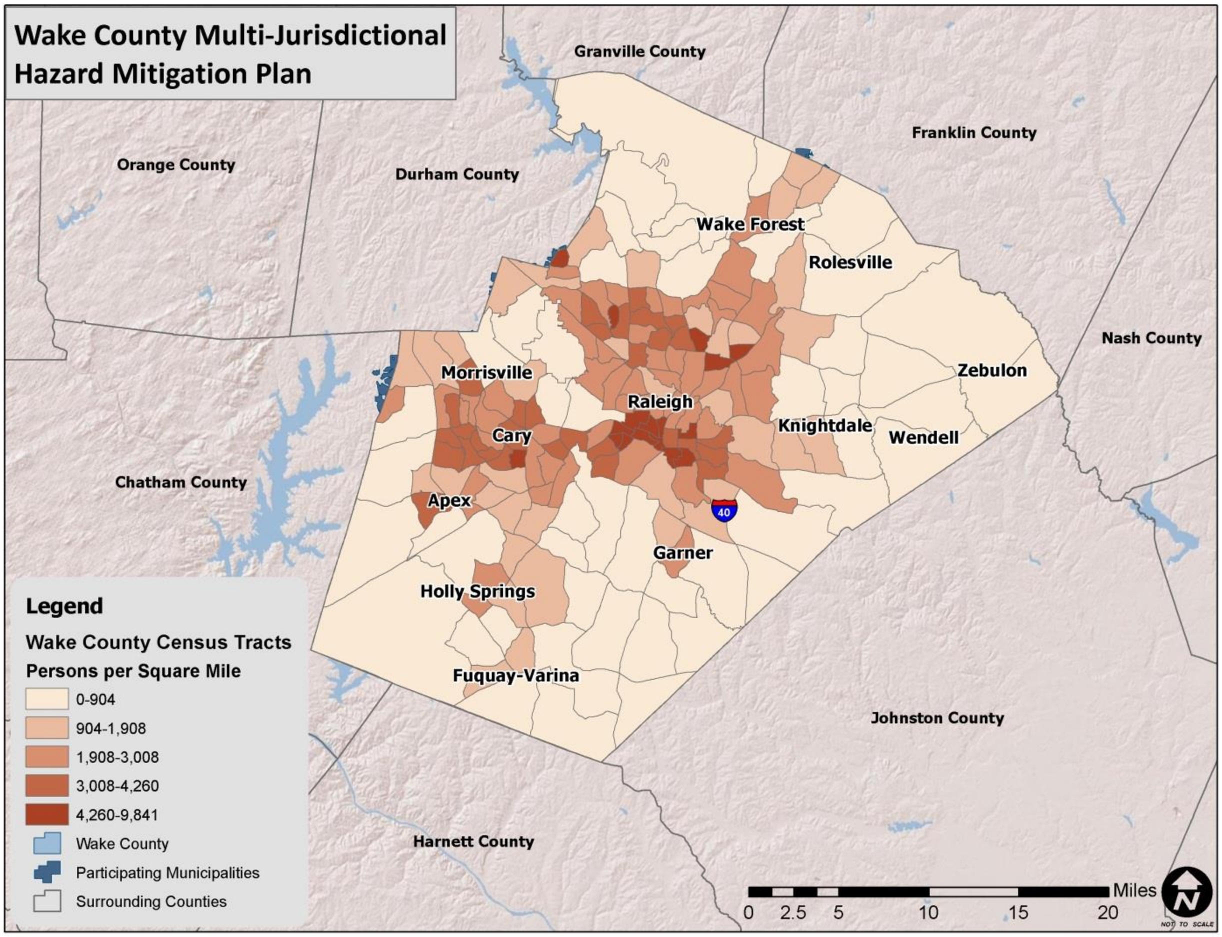
TABLE E.37: TOTAL POPULATION IN HOLLY SPRINGS

Location	Total 2010 Population
Holly Springs	24,661

Source: U.S. Census 2010

In addition, **Figure E.11** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[18]

FIGURE E.11: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

E.3.3 Vulnerability Assessment Results

As noted in Section 6: *Vulnerability Assessment*, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results, specific to Holly Springs, are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total county exposure, and thus risk, was presented in **Table E.35**.

The annualized loss estimate for all hazards is presented at the end of this section in **Table E.47.**

The hazards presented in this section include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

[18] Population by census block was not available at the time this plan was completed.

Hurricane and Tropical Storm

Historical evidence indicates that Holly Springs has a significant risk to the hurricane and tropical storm hazard. Several tracks have come near or traversed through the county, as shown and discussed in Section E.2.4.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes, and high winds and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table E.38.** Only losses to buildings are reported, in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE E.38: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table E.39.**

TABLE E.39: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Holly Springs	74.2	83.4	102.3	109.0

Source: Hazus-MH 2.1

Social Vulnerability

Given equal susceptibility across the county, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Holly Springs, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table E.48** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Holly Springs. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

Earthquake

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table E.40** summarizes the findings.

TABLE E.40: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability

It can be assumed that all existing future populations are at risk to the earthquake hazard.

Critical Facilities

The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table E.48**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Holly Springs. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

Landslide

In order to complete the vulnerability assessment for landslides in Holly Springs, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section E.2.10), tax parcel and building footprint data, and GIS analysis. **Table E.41** presents the potential at-risk property where available. All areas of Holly Springs are identified as low or moderate incidence areas by the USGS landslide data. Some areas are also of moderate landslide susceptibility. Since there were no high incidence levels in the county, the moderate incidence level was used to identify different areas of concern for the analysis below.

TABLE E. 41: TOTAL POTENTIAL AT-RISK PARCELS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	**Moderate**		
Holly Springs	742	95	$114,857,151

Source: USGS

Social Vulnerability

Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides. However, Holly Springs is probably at somewhat higher risk than other jurisdictions.

Critical Facilities

No critical facilities are located in a moderate susceptibility area. A list of specific critical facilities and their associated risk can be found in **Table E.48** at the end of this section.

In conclusion, a landslide has the potential to impact existing and future buildings, facilities, and populations in Holly Springs, though some areas are at a higher risk than others due to a variety of factors. For example, steep slopes and modified slopes bear a greater risk than flat areas. Specific vulnerabilities for county assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

Flood

Historical evidence indicates that Holly Springs is susceptible to flood events. A total of 1 flood event has been reported by the National Climatic Data Center resulting in $0 in damages. On an annualized level, these damages amounted to $0 for Holly Springs.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for the county. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table E.42** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

TABLE E.42: ESTIMATED EXPOSURE OF PARCELS TO THE FLOOD HAZARD

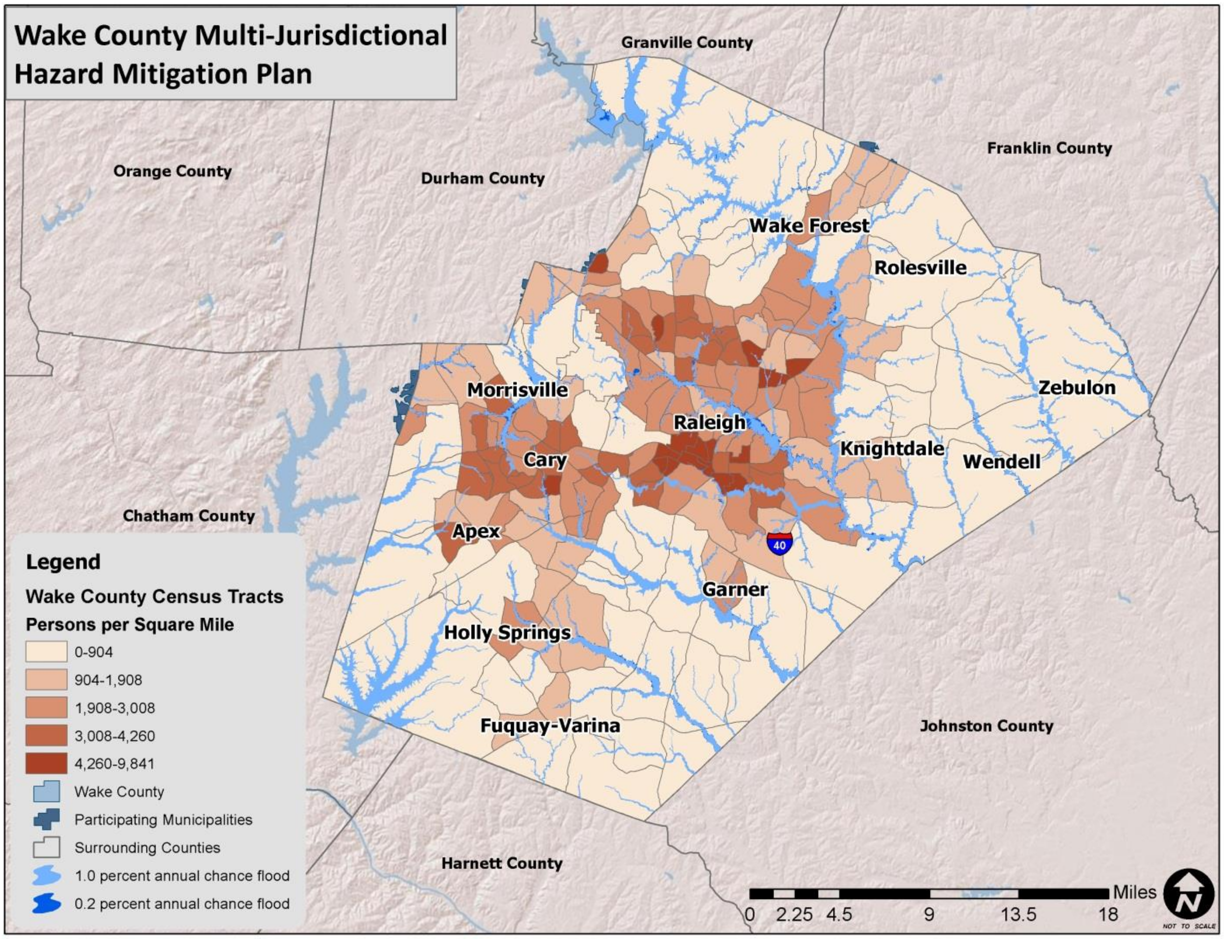
Location	1.0-percent ACF			0.2-percent ACF		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings
Holly Springs	187	23	$62,514,913	51	18	$13,645,602

Source: FEMA DFIRM

Social Vulnerability

Since 2010 population was available at the tract level, it was difficult to determine a reliable figure on population at-risk to flood due to tract level population data. **Figure E.12** is presented to gain a better understanding of at risk population.

FIGURE E.12 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities

The critical facility analysis revealed that there are a no critical facilities located in the Holly Springs 1.0-percent annual chance floodplain and 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. A list of specific critical facilities and their associated risk can be found in **Table E.48** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings and populations in Holly Springs, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

Hazardous Materials Incident

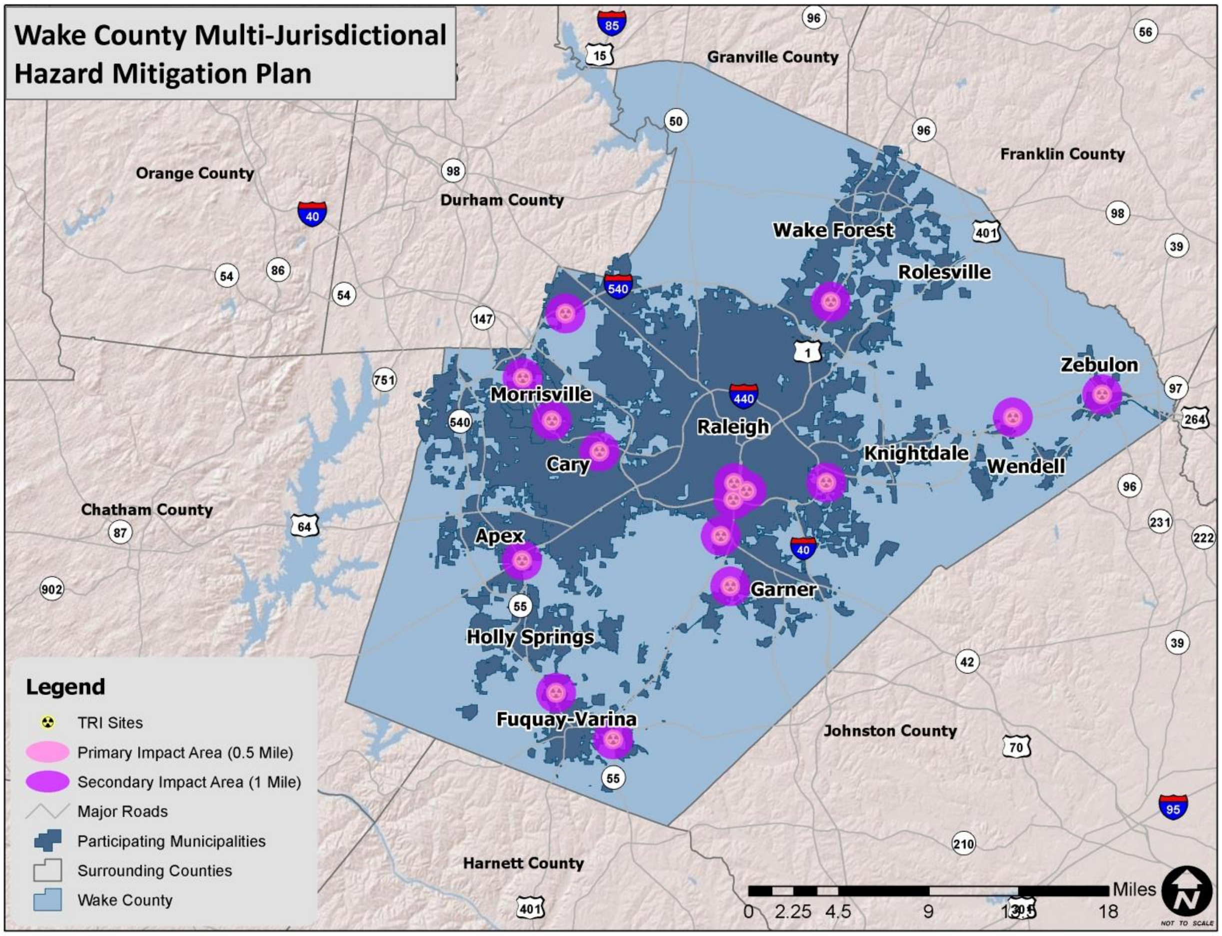
Although historical evidence and existing Toxic Release Inventory sites indicate that Holly Springs is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Holly Springs.

Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[19] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Holly Springs, along with buffers, were used for analysis as shown in **Figure E.13.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the GIS buffer analysis. **Figure E.14** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table E.43** (fixed sites), **Table E.44** (mobile road sites) and **Table E.45** (mobile railroad sites).[20]

[19] This type of analysis will likely yield inflated results (generally higher than what is actually reported after an event).
[20] Note that parcels included in the 1.0-mile analysis are also included in the 0.5-mile analysis.

FIGURE E.13 : TRI SITES WITH BUFFERS IN HOLLY SPRINGS



Source: EPA

TABLE E.43: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Holly Springs	0	0	$0	0	0	$0

FIGURE E.14 : MOBILE HAZMAT BUFFERS IN HOLLY SPRINGS

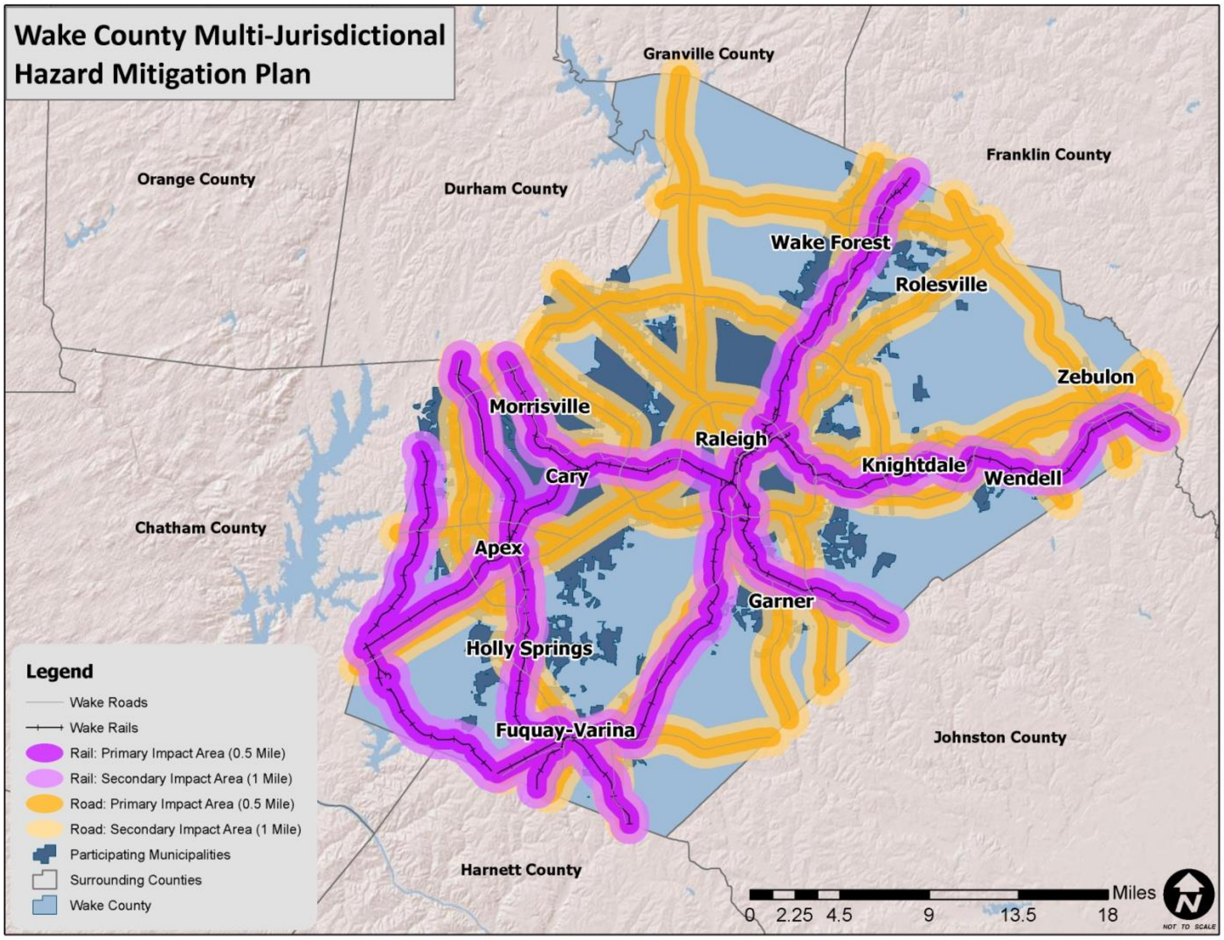


TABLE E.44: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Holly Springs	3,871	3,410	$606,310,663	5,429	4,562	$874,552,521

TABLE E.45: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Holly Springs	3,549	3,093	$549,178,328	5,194	4,416	$836,700,987

Social Vulnerability

Given high susceptibility across the jurisdiction, it is assumed that the total population is at risk to a hazardous materials incident. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities

Fixed Site Analysis:

The critical facility analysis for fixed TRI sites revealed that no critical facilities are located in a HAZMAT risk zone. A list of specific critical facilities and their associated risk can be found in **Table E.48** at the end of this section.

Mobile Analysis:

The critical facility analysis for road and railroad transportation corridors in Holly Springs revealed that there are 8 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 5 facilities. The remaining facilities are in the secondary, 1.0-mile zone. The railroad buffer areas include 8 facilities with 3 in the primary impact zone. It should be noted that many of the facilities located in the buffer areas for railroad are also located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table E.48** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Holly Springs. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc. Further, incidents from neighboring jurisdictions could also have an impact.

Wildfire

Although historical evidence indicates that Holly Springs is susceptible to wildfire events, there are few reports of damage. Upon conversion of the wildfire risk data (see Section 6: *Vulnerability Assessment*) and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the jurisdiction should be assumed to be very low. As such, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the county.

Social Vulnerability

All areas have relatively equal vulnerability and there is low susceptibility across the entire county. It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in wildfire areas of concern. It should be noted, however, that several factors could impact the spread of a wildfire putting all facilities at risk. A list of specific critical facilities and their associated risk can be found in **Table E.48** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Holly Springs.

Nuclear Accident

The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table E.46** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE E.46: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[21]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[22]
Holly Springs	10,014	7,960	$1,895,491,015	10,253	8,162	$1,967,125,463

Social Vulnerability

Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities

The critical facility analysis revealed that there are a total of eighteen critical facilities located in the 10-mile nuclear buffer area including 2 police stations, 5 schools, and 3 others in Holly Springs.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in Holly Springs, though areas closer to the power plant are at a higher risk than others. All structures are at some risk given that they are all located within at least the 50-mile buffer area.

Conclusions on Hazard Vulnerability

Table E.47 presents a summary of annualized loss for each hazard in Holly Springs. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, although an annualized loss was determined through the damage reported through historical occurrences at the municipal level, it is likely that the county-wide

[21] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.

[22] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

estimate (found in Section 6: *Vulnerability Assessment*) is potentially a better estimate. These values should be used as an additional planning tool or measure risk for determining hazard mitigation strategies.

TABLE E.47: ANNUALIZED LOSS FOR HOLLY SPRINGS*

Event	Holly Springs
Dam Failure	Negligible
Drought	Negligible
Erosion	Negligible
Extreme Heat	Negligible
Hail	Negligible
Hurricane & Tropical Storm	Negligible
Landslide	Negligible
Lightning	$487,721
Thunderstorm Wind/High Wind[23]	$6,269
Tornado	Negligible
Winter Storm & Freeze	Negligible
Flood	Negligible
Earthquake	Negligible
HAZMAT Incident	Negligible
Wildfire	Negligible
Nuclear Accident	Negligible
Terror Threat	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table E.48** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

[23] The annualized losses for these hazards were combined.

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TABLE E.48: AT-RISK CRITICAL FACILITIES IN HOLLY SPRINGS

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
HOLLY SPRINGS																								
PUBLIC WORKS BUILDING	OTHER	X	X	X	X	X	X	X	X	X							X	X		X		X	X	X
TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
WASTEWATER TREATMENT PLANT	OTHER	X	X	X	X	X	X	X	X	X							X	X		X		X	X	X
HOLLY SPRINGS	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
LAW ENFORCEMENT CENTER	POLICE STATION	X	X	X	X	X	X	X	X	X								X		X		X	X	X
HOLLY SPRINGS HS	SCHOOL	X	X	X	X	X	X	X	X	X										X		X	X	X
HOLLY SPRINGS ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
HOLLY RIDGE ES	SCHOOL	X	X	X	X	X	X	X	X	X								X				X	X	X
HOLLY RIDGE MS	SCHOOL	X	X	X	X	X	X	X	X	X												X	X	X
HOLLY GROVE ES	SCHOOL	X	X	X	X	X	X	X	X	X								X		X		X	X	X

Secondary Critical Facilities are listed in slight contrast to Critical Facilities as their continued function has not been deemed as critical as primary facilities in the event of a disaster, but these facilities are extremely important. A loss of function to one of these facilities would have a definitively greater negative impact on the community's ability to respond to and recover from a disaster than a loss of function at other facilities/structures within the jurisdiction. In **Table E.49**, these facilities have been classified as either Significant Community Locations/Sheltering Centers or as Critical Resources Management Facilities. These facilities are all vulnerable to any of the atmospheric hazards and many are also likely vulnerable to other hazards identified above, though no locational analysis was carried out to this end.

TABLE E.49: HOLLY SPRINGS SECONDARY CRITICAL FACILITIES

Facility Name	Address*	Type
Holly Springs		
Booster Pump Maintenance Building	Utley Creek	Critical Resources (Energy, Water, etc.)
Elevated Water Storage Tank	1136 Avent Ferry Road	Critical Resources Management (Energy, Water, etc.)
Elevated Water Storage Tank	521 Lee St	Critical Resources Management (Energy, Water, etc.)
Elevated Water Storage Tank	401 Holly Springs Rd	Critical Resources Management (Energy, Water, etc.)
Reclaimed Water Storage Tank	Irving Parkway	Critical Resources Management (Energy, Water, etc.)
Sewer Pump Stations	21 locations	Critical Resources Management (Energy, Water, etc.)
US Post Office		
PSNC Energy Gas Terminal		Critical Resources Management (Energy, Water, etc.)
Duke Progress Energy		Critical Resources Management (Energy, Water, etc.)
BellSouth		Critical Resources Management (Energy, Water, etc.)
Sprint		Critical Resources Management (Energy, Water, etc.)
Solid Waste Facility		Critical Resources Management (Energy, Water, etc.)
W.E. Hunt Community Center/Gym		Significant Community Location or Sheltering Center
Bass Lake Retreat Center		Significant Community Location or Sheltering Center
Holly Springs Cultural Center		Significant Community Location or Sheltering Center

**Some address information could not be provided or was not applicable to the facility*

E.4 TOWN OF HOLLY SPRINGS CAPABILITY ASSESSMENT

This subsection discusses the capability of the Town of Holly Springs to implement hazard mitigation activities. More information on the purpose and methodology used to conduct the assessment can be found in Section 7: *Capability Assessment*.

E.4.1 Planning and Regulatory Capability

Table E.50 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the Town of Holly Springs. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE E.50: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning Tool/Regulatory Tool	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan (Parks & Rec/Greenway Plan	Stormwater Management Plan/Ordinance	Natural Resource Protection Plan	Flood Response Plan	Emergency Operations Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	National Flood Insurance Program (NFIP)	NFIP Community Rating System
Holly Springs	✓	✓		✓	✓			✓				✓			✓	✓	✓	✓		✓	✓	✓	

A more detailed discussion on the town's planning and regulatory capabilities follows.

Emergency Management

Hazard Mitigation Plan
The Town of Holly Springs has previously adopted a hazard mitigation plan.

Emergency Operations Plan
The Town of Holly Springs has adopted the Wake County Emergency Operations Plan.

General Planning

Comprehensive Land Use Plan
The Town of Holly Springs has adopted the *Vision Holly Springs Comprehensive Plan*.

Capital Improvements Plan
The Town of Holly Springs adopts an annual capital improvement plan.

Zoning Ordinance
The Town of Holly Springs includes zoning regulations as part of the local unified development ordinance.

Subdivision Ordinance
The Town of Holly Springs also includes subdivision regulations as part of the local unified development ordinance.

Building Codes, Permitting, and Inspections
North Carolina has a state compulsory building code which applies throughout the state. The building code is enforced within the town's planning jurisdiction by the Town of Holly Springs Code Enforcement/Building Inspections Department.

Floodplain Management

Table E.51 provides NFIP policy and claim information for the Town of Holly Springs.

TABLE E.51: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
Holly Springs	12/23/94	04/16/07	74	$20,803,800	3	$32,312

Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Flood Damage Prevention Ordinance
All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. The Town of Holly Springs participates in the NFIP and has adopted flood damage prevention regulations.

Open Space Management Plan
The Town of Holly Springs has adopted an open space master plan as well as a parks and recreation master plan.

Stormwater Management Plan
The Town of Holly Springs has not adopted a stormwater management plan; however, the town has adopted a stormwater ordinance.

E.4.2 Administrative and Technical Capability

Table E.52 provides a summary of the capability assessment results for the Town of Holly Springs with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in the town with the specified knowledge or skill.

TABLE E.52: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	Planners with knowledge of land development/land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency Manager	Floodplain Manager	Land Surveyors	Scientists familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Resource development staff or grant writers
Holly Springs	✓	✓	✓	✓	✓		✓	✓	✓	

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

E.4.3 Fiscal Capability

Table E.53 provides a summary of the results for the Town of Holly Springs with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plan.

TABLE E.53: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes (or taxing districts)	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.
Holly Springs	✓	✓	✓					✓	✓	✓

E.4.4 Political Capability

The citizens, property owners, business owners, and elected officials of the Town of Holly Springs are committed to improving the greater community through coordinated hazard mitigation planning efforts. In the coming years, the Town of Holly Springs will continue to take a proactive role in planning for and encouraging mitigation of hazards that put citizens and property at risk. The Mayor of Holly Springs along with the elected board members continually strive to make the Town of Holly Springs a safer community and see the hazard mitigation plan as an essential component in helping to achieve their goal "to foster, maintain, and enhance a village atmosphere that evokes a sense of place."

E.4.5 Conclusions on Local Capability

Table E.54 shows the results of the capability assessment using the designed scoring methodology described in Section 7: *Capability Assessment*. The capability score is based solely on the information found in existing hazard mitigation plan and readily available on the town's government website. According to the assessment, the local capability score for the town is 40, which falls into the high capability ranking.

TABLE E.54: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
Holly Springs	40	High

E.5 TOWN OF HOLLY SPRINGS MITIGATION STRATEGY

This subsection provides the blueprint for Holly Springs to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Regional Work Groups and the findings and conclusions of the capability assessment and risk assessment. Additional Information can be found in Section 8: *Mitigation Strategy* and Section 9: *Mitigation Action Plan*.

E.5.1 Mitigation Goals

Holly Springs developed seven mitigation goals in coordination with Wake County and the other participating municipalities. The county-wide mitigation goals are presented in **Table E.55**.

TABLE E.55: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

E.5.2 Mitigation Action Plan

The mitigation actions proposed by Holly Springs are listed in the following Mitigation Action Plan.

Town of Holly Springs Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Adopt Building Code	All	High	Holly Springs Code Enforcement	Local	Completed	The Town administers a program upholding the 2002 International Building Code with North Carolina Amendments. These regulations provide guidance for design criteria for flood, roof snow load, winter design, wind speed, seismic design, weathering, frost line depth, termite infestation and decay. This action will be removed from the next update
P-2	Develop Vision Holly Springs Comprehensive Plan	All	Moderate	Holly Springs Planning & Zoning	Local	Completed	The Town has an existing Comprehensive Plan which includes Land Use, Parks and Recreation, Public Safety, Economic Development, Transportation, Public Utilities and Environment. This plan includes past and current conditions and sets goals for future needs of the Town. The Hazard Mitigation Plan will be incorporated as an additional component of the CGP at plan update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-3	Develop Land Use Plan	All	High	Holly Springs Planning & Zoning	Local	Completed	This is an existing tool which guides development in Town based on proposed future land use designations, available services, and existing site features to ensure that future development is meeting the overall vision of the Town while insuring the safety of its citizens. This action will be removed from the next update
P-4	Implement Floodplain Development Regulations to minimize public and private losses due to flood conditions.	Flood	High	Holly Springs Engineering	Local	Completed	The Town has an ordinance developed to minimize public and private losses due to flood conditions. The latest update of the Flood Damage Prevention Ordinance was May 2, 2006. (00-23) This action will be removed from the next update
P-5	Implement Floodplain Development Regulations to restrict or prohibits uses which are dangerous to health, safety and property	Flood	High	Holly Springs Engineering	Local	Completed	The Town restricts or prohibits uses which are dangerous to health, safety and property due to water or erosion hazards or which result in damaging increases in erosion or in flood heights or velocities. (00-23) This action will be removed from the next update
P-6	Implement Floodplain Development Regulations that require that uses vulnerable to floods be protected against flood damage at the time of initial construction	Flood	High	Holly Springs Engineering	Local	Completed	The Town has a program that requires that uses vulnerable to floods be protected against flood damage at the time of initial construction. (00-23) This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-7	Implement Floodplain Development Regulations to control the alteration of natural floodplains, stream channels and natural protective barriers	Flood	High	Holly Springs Engineering	Local	Completed	The Town has an ongoing program that controls the alteration of natural floodplains, stream channels and natural protective barriers which are involved in the accommodation of flood waters (00-23) This action will be removed from the next update
P-8	Implement Floodplain Development Regulations to control filling, grading, dredging and other development	Flood	High	Holly Springs Engineering	Local	Completed	The Town has an ongoing program that controls filling, grading, dredging and other development which may increase erosion or flood damage (00-23) This action will be removed from the next update
P-9	Implement Floodplain Development Regulations related to participating in the National Flood Insurance Program	Flood	High	Holly Springs Engineering	Local	2016	The Town evaluated the Town's potential participation in the Community Rating System (CRS) and determined that the amount of insured properties in the Town did not warrant participation in the CRS. However, staff will reevaluate this determination in the future through the implementation of the Floodplain Management Program. Will re-evaluate in 2016.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-10	Implement Floodplain Development Regulations – to prevent or regulate the construction of flood barriers which will unnaturally divert flood waters	Flood	High	Holly Springs Engineering	Local	Completed	The Town has an ongoing program that prevents or regulates the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards to other lands (00-23). This action will be removed from the next update
P-11	Increase Open Space Preservation	Flood	High	Holly Springs Parks & Recreation	Local State	Completed	The Town has an existing Open Space Master Plan which identifies and evaluates various land and open space resources throughout the ETJ and Urban Service areas of the Town. The Plan is used to develop a prioritization system that can be used by all Town departments for identifying properties to acquire or require as open space from developers as the Town grows. This action will be removed from the next update
P-12	Adopt Unified Development Ordinance (UDO)	All	High	Holly Springs Planning & Zoning	Local	2015, review and update annually	The Town has an existing UDO which regulates development to ensure safety from fire, panic and other dangers. The UDO provides for orderly growth and development within the Town and ETJ by determining appropriate land use and development standards. The UDO is in place, but the town will update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-13	Adopt Water Shortage and Conservation Ordinance	Droughts and Heat Waves	High	Holly Springs Engineering	Local	Completed	The Town has an existing ordinance that is designed: (1) to implement permanent seasonal water conservation measures; (2) to provide for the declaration of increasingly serious stages of water shortages, and (3) to define mandatory water conservation measures to be implemented during these various stages. The Water Shortage and Conservation Ordinance is intended to preserve the water resources of the Town under specific conditions so that water demands for human consumption, sanitation, and fire protection can be met as cost-efficiently as possible throughout the service area. (98-10). This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-14	Adopt Stormwater Management Regulations	Flood	High	Holly Springs Engineering	Local	2019	The Town maintains numerous basin HEC-HMS and HEC-RAZ models to determine the water surface elevation where nuisance flooding is a known problem. To ensure that water surface elevations and velocities in the streams do not get worse, the Town has adopted a policy to require new development, to run the model with the proposed development and to add stormwater BMPs or other measures to make sure that there is not a negative impact downstream. When new developments occur, models will need to be re-run.
P-15	Carry out Water System Vulnerability Assessment	All	High	Holly Springs Public Utilities, Engineering	Local	Completed	This assessment was completed in 2004
Property Protection							
PP-1	Implement Minimum Standards Ordinance	All	High	Holly Springs Code Enforcement	Local	Completed	The Town has a program which inspects existing structures to ensure that they meet the Minimum Housing Standards Ordinance. Structures that do not meet these requirements will be ordered to bring up to minimum standards, demolished or removed. Safety officer in code enforcement department handles this program. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PP-2	Barrier Installation.	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town has an ongoing program that prevents or regulates the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards to other lands (00-23). The NPDES Phase II Stormwater Illicit Discharge Detection & Elimination Regulations has provisions for watercourse protection which requires property owners to keep and maintain the watercourse free of trash, debris, excessive vegetation and other obstacles that would pollute, contaminate or significantly retard flow of the water through the watercourse. This action will be removed from the next update
PP-3	Building Acquisition and Clearance - The Town is willing to develop a plan designed to utilize Federal grant resources to assist private property owners in purchasing properties located in flood hazard zones.	Flood	Low	Holly Springs Code Enforcement	Local, State, Federal	2017	No such program is in the works at this time. The town will need to evaluate properties that are potentially eligible and determine if funding is available
PP-4	Building Elevation.	Flood	High	Holly Springs Engineering	Local, State, Federal	Completed	The Town has an existing program which requires all residential and commercial finished floors to meet a minimum of 2-foot freeboard over the base flood elevation. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PP-5	Building Relocation - The Town is willing to develop a plan designed to utilize Federal grant resources to assist private property owners in relocating existing structures out of flood hazard zones.	Flood	Low	Holly Springs Code Enforcement	Local, State, Federal	2017	No such program is in the works at this time. The town will need to evaluate properties that are potentially eligible and determine if funding is available
PP-6	Building Retrofit - The Town is willing to develop a plan to utilize Federal grant resources to assist private property owners in renovating and retrofitting existing structures in flood hazard zones to reduce vulnerability to flooding damage.	Flood	Low	Holly Springs Code Enforcement	Local, State, Federal	2017	No such program is in the works at this time. The town will need to evaluate properties that are potentially eligible and determine if funding is available
PP-7	Bass Lake Area Plan - Design a plan specific to the Bass Lake line to determine mitigation in the event of a spill or disaster.	Flood	High	Holly Springs Public Utilities Public Works	Local	Deleted	Removed from actions due to infeasibility
PP-8	Outfall Maintenance	Flood	High	Holly Springs Public Works	Local	Completed	Continue sewer easement clearing and aerial main inspections/clearing to prevent and eliminate obstructions and erosion that can lead to infrastructure failure, as required by NC DENR DWQ regulations. The Town also uses cameras and jet smoke for inspection purposes.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PP-9	Purchase of Open Space, Parks and Greenways	Flood	Moderate	Holly Springs Parks and Recreation	Local	2018	The town has acquired hundreds of acres of open space in recent years. The Parks and Recreation Department is asking for $500,000 for Capital Improvement Projects to purchase open space. The Town also works with Wake County and other agencies to find other funding for open space acquisition. Once funds are obtained the Town will acquire land consistent with Land Use and Master Open Space Plans.
PP-10	Enforce Open Space Requirements	Flood	Moderate	Holly Springs Parks and Recreation	Local	Completed	The Town requires every subdivision to provide open space or a fee-in-lieu which will be used to purchase property consistent with Land Use and Master Open Space Plans. This action will be removed from the next update
Natural Resource Protection							
NRP-1	Institute Best Management Practices (BMPs) for NPDES Phase II Post-Construction Stormwater Regulations	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town adopted NPDES Phase II Post-Construction Stormwater Regulations on November 6, 2007 and updated Section 8 of the Engineering Design & Construction Standards to address both water quality and water quantity management on sites. Staff is currently implementing this program. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-2	Develop Erosion and Sedimentation Control program	Flood	Moderate	Holly Springs Engineering	Local	Completed	Local program to enforce Erosion and Sedimentation Control standards. Local sedimentation control program complements state program.This action will be removed from the next update
NRP-3	Encourage good Forestry Practices.	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town has an existing program which requires a separate timbering plan within the Town Limits and ETJ. The Town received legislative authority in January 2004 to design and adopt ordinances to regulate the removal and preservation of trees within the Town Limits. Staff is currently working on updates to these regulations. This action will be removed from the next update
NRP-4	Encourage Habitat Protection	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town has existing riparian buffer and open space programs which allow for habitat protection. The Town also has additional requirements for areas where there are known threatened or endangered species, i.e., the Town has additional development requirements upstream of SR 1112 to protect the Eastern Tiger Salamander habitat which is negatively impacted by flooding of the pools adjacent to the floodplain. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-5	Discourage Stream Dumping	Flood	Low	Holly Springs Engineering	Local	Completed	The Town adopted the NPDES Phase II Stormwater Illicit Discharge Detection & Elimination Regulations on December 16, 2008 which enforces illicit discharges, illegal connections in or draining to the towns storm drainage system & blockages in watercourses. This action will be removed from the next update
NRP-6	Enforce Wetlands Protection	Flood	Moderate	Holly Springs Engineering, Code Enforcement	Local	Completed	The Town has existing Riparian Buffer, Open Space, and Flood Damage Prevention ordinances that restrict development along streams and in the floodplain thus restricting development in much of the Town's wetland areas. Engineering Design Standards require that all impacts to wetlands be permitted by the US Army Corps of Engineers and the NC DENR Division of Water Quality prior to issuance of a Land Disturbance Permit. The Town also has an existing program that ensures that structures, through review of the Building Permit application, are not constructed in the wetlands unless permitted by the appropriate Federal and State Agencies. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Structural Projects							
SP-1	Implement Channel Maintenance	Flood	High	Holly Springs Public Works	Local	Completed	The Town currently maintains all channels and culverts located within public right-of-way. These channels are inspected and maintained as needed to prevent failure or blockages. This action will be removed from the next update
SP-2	Implement Channel Modifications.	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town modifies channels through the construction of various road projects and ensures through the design that all State and Federal regulations are met. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
SP-3	Implement Channel Modifications & Maintenance	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town's drainage policies and Section 8 of the Engineering Design & Construction Standards include provisions not to maintain or modify drainage features on private property. With the design of a comprehensive stormwater management program the Town may consider changing Town Policy and set up a Stormwater Utility to undertake channel maintenance and modification projects on private property. In areas where there is finished floor flooding after Town Board approval the Town may assist residents in obtaining grant funding for stream restoration projects from available funding sources where the municipality must be the applicant for a project of that nature to be undertaken. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
SP-4	Implement Channel Modifications	Flood	Low	Holly Springs Engineering	Local	Deleted	Incorporated with S-3 above- The Town's drainage policies and Section 8 of the Engineering Design & Construction Standards include provisions not to maintain or modify drainage features on private property. In areas where there is finished floor flooding after Town Board approval the Town may assist residents in obtaining grant funding for stream restoration projects from available funding sources where the municipality must be the applicant for a project of that nature to be undertaken.
SP-5	Install Reservoirs/Retention/Detention Basins	Flood	Moderate	Holly Springs Parks & Recreation	Local	Completed	The Town does not currently maintain any retention or detention basins. The Town does maintain Bass Lake Dam. The Town regularly provides maintenance of vegetation and minor erosion while providing visual inspections of the dam. If larger repairs are required the Town will find appropriate means to resolve the problem. The Town also has a few small ponds located on existing parks. The Town maintains these ponds consistent with measures taken to maintain the Bass Lake Dam. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
SP-6	GPS Project to identify stormwater issues	All	Moderate	Holly Springs Engineering	Local	Completed	The Town locates and maps the sanitary sewer and water systems with GPS. The Town is currently in the process of locating points on stormwater outfalls. New development must also tie their sites into this system. GIS project is updated with new development. This action will be removed from the next update
Emergency Services							
ES-1	Tracking of Known Drainage, Erosion and Flooding Problems	Flood	Moderate	Holly Springs Engineering	Local	Completed	The Town has a current program to track drainage complaints, flooding and erosion problems within the town limits and ETJ. The Town maintains a complaint log, map of problem areas and photos to monitor the problem over time. The Town has also developed an inter-departmental office procedure for the Engineering Department to address Hurricane/Storm Preparation – Disaster to assist in the coordination between departments after an event, document flood & erosion and provide opportunity to revise the process for future events. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-2	Identification of Unsafe Structures	All	High	Holly Springs Code Enforcement	Local Federal	Completed	The Town has a continuing program which identifies unsafe structures after instances where damage to the structures could take place, e.g., strong winds or flooding. This action will be removed from the next update
ES-3	Backup Power to Fire and Police Stations	All	High	Holly Springs Public Safety	Local Federal	Completed	The Town provides backup power to all fire and police stations. Fire Station 1 – backup power provided by a grant; backup power to Fire Station 2 and Fire Station 3 and Police Station provided by local funds.
ES-4	Keep Technical Rescue Capabilities updated	All	High	Holly Springs Public Safety	Local Federal	2019	Regional technical rescue teams in place. We have automatic aid in place for their use. However, technical rescue capabilities could be improved with further funding and staff.
ES-5	Carry out After Action Report.	All	High	Holly Springs Public Safety	Local	Completed	The HSFD conducts after-action briefings and reports for all significant incidents. This action will be removed from the next update
ES-6	Develop Standard Operating Guidelines	All	High	Holly Springs Public Safety	Local	Completed	SOGs were implemented in 2014 and will remain in effect going forward. This action will be removed from the next update
ES-7	Utilize GIS Programming to address hazards	All	Low	Holly Springs Public Safety	Local	2018	No current implementation plan in place. The town will look to develop this going forward.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-8	Have Urban Search and Rescue available	All	High	Holly Springs Public Safety	Local	2015	The Town currently has US&R services provided through the NC US&R team region 4, with backup assistance provided by region 8. Internally, we provide urban search and rescue services consisting of structural collapse and similar emergencies. .We will continue the use of NC US&R Teams. We currently do not have enough staffing and equipment to handle this on our own. We are looking at the possibility of moving to an intermediate level of training. Implementation goal 2015
ES-9	Purchase Warning Systems	All	High	Holly Springs Public Safety	Local, State	Deleted	The Town currently uses Wake County's warning systems.
ES-10	Purchase Warning Barricades	All	High	Holly Springs Public Safety	Local	Deleted	The Town uses visual warning barricades for vehicular and pedestrian traffic to block properties, roadways, etc. for the safety of the general public.
ES-11	Purchase Trailer Transportation.	All	high	Holly Springs Public Safety	Local	Deleted	Deploy step van and tandem axel trailers for transportation of emergency barricades and other equipment on a large scale.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-12	ECC Notifications by NOAA for possible severe weather (tornados, ice, etc.).	All	High	Holly Springs Public Safety	local	2017	ECC is notified by both agencies when weather alerts are issued. Information is then broadcast over police radios. This information is generated by the State and Wake County and is obtained through the use of DC message, radio, fax and Nextel. This is in place. The information flow needs some work. There were discussions on utilization of WEB EOC, not sure where implementation of that is.
ES-13	Purchase ACU 1000 Communications Unit	All	High	Holly Springs Public Safety	Local	Deleted	This action has been deleted due to infeasbility
ES-14	Develop Water Emergency Response Plan	All	High	Holly Springs Public Utilities, Engineering	local	Completed	Secondary water sources available during an emergency. A plan has been developed. This action will be removed from the next update
ES-15	Implement Tabletop Exercise Program	All	High	Holly Springs Public Safety	N/A	Completed	Tabletop exercises are held through public safety periodically and will continue to be done. This action will be removed from the next update
ES-16	Emergency Response Plans for the Police Station	All	High	Holly Springs Public Safety	Local	Completed	An emergency response plan is in place and will continue to be evaluated. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-17	Install Emergency Generator	All	Moderate	Holly Springs Public Works	Local	2018	The Town currently has an emergency generator to provide power to the Front Office of the Public Works Building during emergencies. Future goal is to provide 100% generator power to the building.
ES-18	Install additional Generators	All	High	Holly Springs Public Utilities	Local	2019	The wastewater treatment plant and sewer lift stations built after 1994 have generators. In emergency situations, the Town also has mobile generators to be used at lift stations built between 1985 – 1994 that are without permanent generators on site. Over the next ten years, the Town would like to purchase generators for lift stations that do not currently have generators.
ES-19	Mobile Command Post-Available 24 hours a day	All	High	Holly Springs Public Safety	Local State	Completed	Available 24 hours a day and equipped to communicate with all agencies in the Triangle including Emergency Management, State agencies, fire departments, etc .Partial availability and access to Wake EM Command Post This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-20	Drought Preparedness	All	High	Holly Springs Engineering, Public Utilities	Local	Completed	The Town has a drought preparedness and response program that includes conservation regulations, enforcement programs, and preliminary arrangements for alternate sources of water supply. This action will be removed from the next update
ES-21	Develop Emergency Response Plans	All	High	Holly Springs Public Safety	Local	Completed	Emergency response plans are all designed for officers to be assigned for security purposes until owners can take over the responsibility of securing premises. This action will be removed from the next update
ES-22	Adopt Mutual Aid	All	High	Holly Springs Public Works	Local	Completed	The Town of Holly Springs participates in NC water and sewer utilities mutual aid provision and system development. This action will be removed from the next update
ES-23	Implement Sewer Bypasses/Overflows	All	High	Holly Springs Public Utilities	Local	Completed	The Town has a wastewater flow equalization facility at the wastewater treatment plant to prevent sewer bypasses and sanitary sewer overflows in high flow events. Berms have also been installed around the water treatment plant and some of the sewer lift stations. The goal is to put berms around all lift stations as funds are acquired. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-24	Provide Counseling	All	High	Holly Springs Public Safety	Local	Completed	Police psychologist and Critical Incident Stress Debriefing Team training to provide debriefing sessions for personnel. This action will be removed from the next update
Public Education and Awareness							
PEA-1	Disseminate Environmental Education	Flood	High	Holly Springs Engineering	Local	Completed	The Town currently has a program which includes environmental education for the public through Town festivals (Holly Fest), public meetings, brochures and preconstruction meetings. The Town operates the Bass Lake Retreat Center which will allow for space to hold additional environmental education activities. The Town will also expand its current education activities to meet NPDES Phase II requirements. The Town's Environmental Education focuses on flooding, drainage, the National Flood Insurance Program, NPDES Phase II, Erosion & Sedimentation Control, Habitat Preservation, etc. This action will be removed from the next update

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-2	Disseminate Map Information	Flood	High	Holly Springs Engineering Planning & Zoning	Local	Completed	The Town maintains current FIRM maps and studies for the Town limits and ETJ. The Town also maintains all current land use, structure and development maps. All maps are available for the public use. This action will be removed from the next update
PEA-3	Develop Website	All	High	Holly Springs Governing Body	Local	2017	The Town maintains its own website which is able to provide up to date information for the public. The Town is continuously updating the site with additional resources. This action will be carried over as updates will need to be made to website.

Annex F
Town of Knightdale

This annex includes jurisdiction-specific information for the Town of Knightdale. It consists of the following five subsections:

- F.1 Town of Knightdale Community Profile
- F.2 Town of Knightdale Risk Assessment
- F.3 Town of Knightdale Vulnerability Assessment
- F.4 Town of Knightdale Capability Assessment
- F.5 Town of Knightdale Mitigation Strategy

F.1 TOWN OF KNIGHTDALE COMMUNITY PROFILE

F.1.1 Geography and the Environment

Knightdale is a town located in Wake County in the state of North Carolina. It was incorporated in 1927 and named after Henry Haywood Knight who donated some of the land in hopes of having a railroad built through the community.

Overall, Wake County is known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Summer temperatures generally venture into the 90s for highs and cool off to the 70s at night. Winter temperatures can drop to below freezing but generally highs are in the 50s. Rainfall is most common in the summer months but occurs consistently throughout the year.

F.1.2 Population and Demographics

According to the 2010 Census, Knightdale has a population of 11,401 people. The jurisdiction has seen exceptional growth between 2000 and 2010, and the population density is almost 1,900 people per square mile. Population counts from the US Census Bureau for 1990, 2000, and 2010 are presented in **Table F.1**.

TABLE F.1: POPULATION COUNTS FOR KNIGHTDALE

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
KNIGHTDALE	1,884	5,958	11,401	91.36%

Source: US Census Bureau

The racial characteristics of the jurisdiction are presented in **Table F.2**. Whites make up half of the population in the jurisdiction, with blacks accounting for nearly 40 percent of the population.

TABLE F.2: DEMOGRAPHICS OF KNIGHTDALE

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
KNIGHTDALE	50.0%	38.3%	0.6%	11.1%	11.4%

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

F.1.3 Housing

According to the 2010 US Census, there are 8,658 housing units in Knightdale, the majority of which are single family homes or mobile homes. Housing information for the jurisdiction is presented in **Table F.3**.

TABLE F.3: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Seasonal Units, Percent (2010)	Median Home Value (2006-2010)
KNIGHTDALE	3,642	8,658	5.9%	$236,700

Source: US Census Bureau

F.1.4 Infrastructure

Transportation
There are several major roadways that residents of Knightdale utilize. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs, one of which is I-540/NC-540, a partly completed loop that connects the jurisdiction to many of the other municipalities. I-495 has also been marked between I-440 and I-540 and will eventually be marked all the way to I-95 in Rocky Mount. In addition to the Interstate, there are many major highways that residents of the municipality utilize. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities
Electrical power in the jurisdiction is provided by two entities: Duke Energy and Wake Electric Membership Corporation with Duke Energy providing service to a majority of the service. Water and sewer service is provided by the City of Raleigh Public Utilities. Natural gas is provided by PSNC Energy.

Community Facilities

There are a number of public buildings and community facilities located throughout Knightdale. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 3 fire stations, 1 police station, and 6 public schools located within the town.

Citizens also have access to several parks, including three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the county, including the Neuse River Trail in Raleigh and the Mingo Creek Trail that connects to it in Knightdale. There are also many miles of trail within that trail system which are open to a wide variety of non-motorized uses.

F.1.5 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land as parks and open space. There are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the municipality consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

F.1.6 Employment and Industry

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

F.2 TOWN OF KNIGHTDALE RISK ASSESSMENT

This subsection includes hazard profiles for each of the significant hazards identified in Section 4: *Hazard Identification* as they pertain to Knightdale. Each hazard profile includes a description of the hazard's location and extent, notable historical occurrences, and the probability of future occurrences. Additional information can be found in Section 5: *Hazard Profiles*.

F.2.1 Drought

Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, Knightdale has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that the county would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Historical Occurrences

According to the North Carolina Drought Monitor, Knightdale has had drought occurrences all of the last fourteen years (2000-2013). **Table F.4** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE F.4: HISTORICAL DROUGHT OCCURRENCES IN KNIGHTDALE

Abnormally Dry	Moderate Drought	Severe Drought	Extreme Drought	Exceptional Drought

	Knightdale
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that Knightdale has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location, but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

F.2.2 Extreme Heat

Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to geographic or political boundaries. All of Knightdale is susceptible to extreme heat conditions.

Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Knightdale. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from the Enloe High School track team collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the region. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the county. The most centralized location is in Raleigh at North Carolina State University. **Table F.5** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table F.5: Average Maximum Temperature in Raleigh, Wake County

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

F.2.3 Hailstorm

Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Knightdale is uniformly exposed to severe thunderstorms; therefore, all areas are equally exposed to hail which may be produced by such storms.

Historical Occurrences

According to the National Climatic Data Center, 8 recorded hailstorm events have affected Knightdale since 1993.[1] **Table F.6** is a summary of the hail events in Knightdale. **Table F.7** provides detailed information about each event that occurred. In all, hail occurrences resulted in $0 (2013 dollars) in property damages. Hail ranged in diameter from 0.75 inches to 1.75 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value.

Table F.6: Summary of Hail Occurrences in Knightdale

Location	Number of Occurrences	Property Damage (2013)
Knightdale	8	$0

Source: National Climatic Data Center

[1] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Knightdale. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

TABLE F.7: HISTORICAL HAIL OCCURRENCES IN KNIGHTDALE

	Date	Magnitude	Deaths/Injuries	Property Damage*
Knightdale				
KNIGHTDALE	5/29/1996	0.75 in.	0/0	$0
KNIGHTDALE	5/7/1998	0.75 in.	0/0	$0
KNIGHTDALE	4/1/2001	1 in.	0/0	$0
KNIGHTDALE	8/5/2004	0.75 in.	0/0	$0
KNIGHTDALE	3/28/2005	0.75 in.	0/0	$0
KNIGHTDALE	5/25/2006	1.75 in.	0/0	$0
KNIGHTDALE	5/20/2008	0.75 in.	0/0	$0
KNIGHTDALE	5/5/2009	1 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that Knightdale has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the county.

F.2.4 Hurricane and Tropical Storm

Location and Spatial Extent

Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Knightdale. The entire jurisdiction is equally susceptible to hurricane and tropical storms.

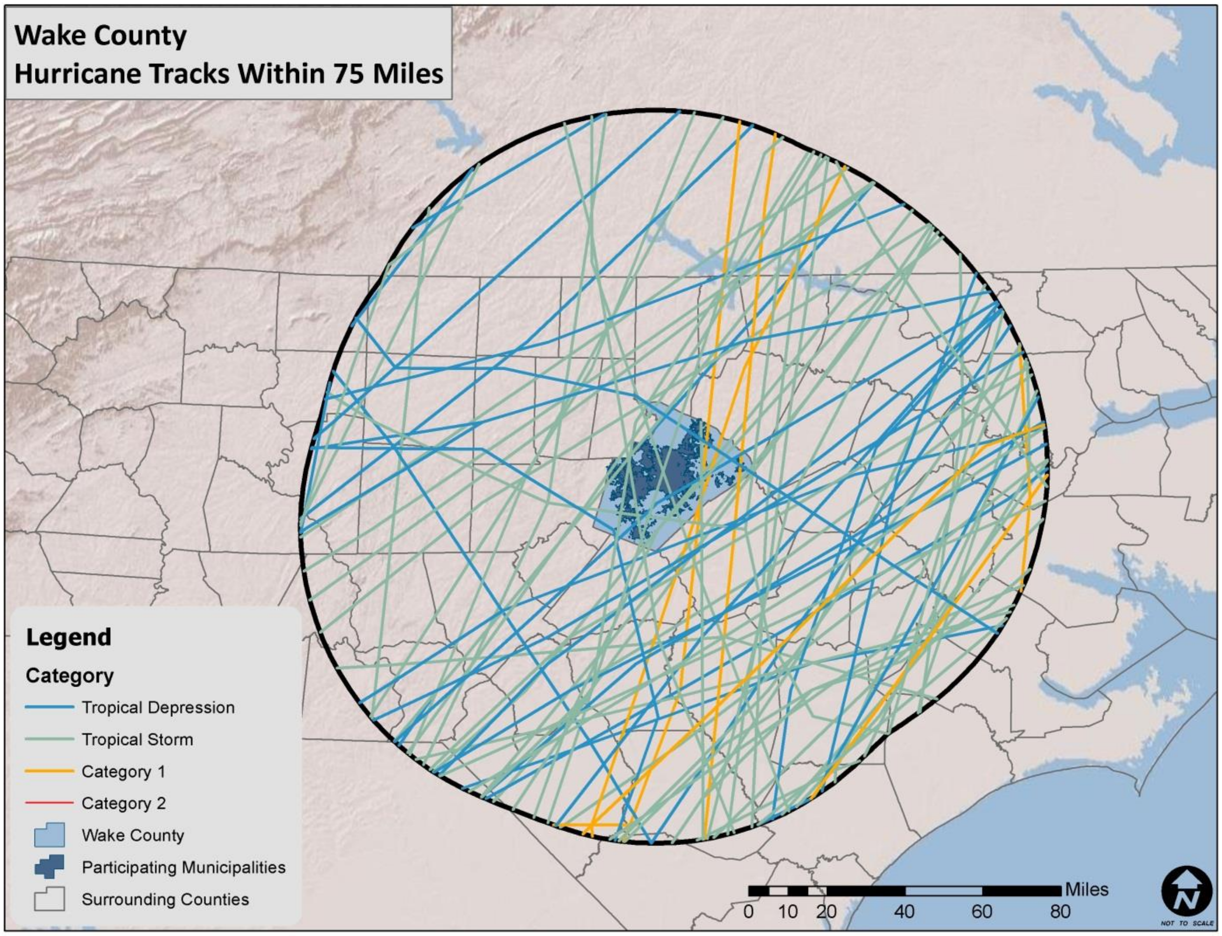
Historical Occurrences

According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[2] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms have traversed directly through Wake County as shown in **Figure F.1**. **Table F.8** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

[2] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

FIGURE F.1: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE F.8: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1
1882	NOT NAMED	53	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm
1959	CINDY	26	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression
2008	HANNA	40	Tropical Storm

Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Knightdale between 1950 and 2013. These storms are listed in **Table F.9** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE F.9: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made for the county: Hurricane Fran (1996), Hurricane Floyd (1999), and Hurricane Isabel (2003).[3]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Hurricane Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

Probability of Future Occurrences
Given the inland location of the jurisdiction, it is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Knightdale. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the jurisdiction is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

[3] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

F.2.5 Lightning

Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Knightdale is uniformly exposed to lightning.

Historical Occurrences

According to the National Climatic Data Center, there have been two recorded lightning events in Knightdale since 1950, as listed in summary **Table F.10** and detailed in **Table F.11**.[4] However, it is certain that more lightning events have in fact impacted the jurisdiction. Many of the reported events are those that caused damage, and it should be expected that damages are likely much higher for this hazard than what is reported.

TABLE F.10: SUMMARY OF LIGHTNING OCCURRENCES IN KNIGHTDALE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Knightdale	2	1/0	$11,255

Source: National Climatic Data Center

TABLE F.11: HISTORICAL LIGHTNING OCCURRENCES IN KNIGHTDALE

	Date	Deaths/Injuries	Property Damage*	Details
Knightdale				
KNIGHTDALE	7/13/2005	1/0	$0	A smoldering tree which had been struck by lightning a few hours earlier fell, killing a firefighter.
KNIGHTDALE	7/17/2010	0/0	$11,255	Thunderstorms developed across Virginia and central North Carolina as a small long lived MCS crossed the central and southern Appalachians. Widespread wind damage was reported across northern and central portions of central North Carolina.

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Although there were not a high number of historical lightning events reported in Knightdale via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S.

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Knightdale. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

National Lightning Detection Network (NLDN®), Knightdale is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the jurisdiction.

F.2.6 Severe Thunderstorm/High Wind

Location and Spatial Extent

A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Also, Knightdale typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Knightdale has uniform exposure to an event and the spatial extent of an impact could be large.

Historical Occurrences

Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011.[5] According to NCDC, there have been 2 reported thunderstorm/high wind events since 1950.[6] These events caused over $1,000 (2013 dollars) in damages. **Table F.12** summarizes this information. **Table F.13** presents detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event.[7]

TABLE F. 12: SUMMARY OF THUNDERSTORM/HIGH WIND OCCURRENCES IN KNIGHTDALE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Knightdale	2	0/0	$1,126

Source: National Climatic Data Center

TABLE F.13: HISTORICAL THUNDERSTORM/HIGH WIND OCCURRENCES IN KNIGHTDALE

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Knightdale					
KNIGHTDALE	6/13/2010	THUNDERSTORM WIND	50 kts.	0/0	$1,126
KNIGHTDALE	4/5/2011	THUNDERSTORM WIND	50 kts.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

[5] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional thunderstorm events have occurred in Knightdale. As additional local data becomes available, this hazard profile will be amended.
[7] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

Probability of Future Occurrences

Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire jurisdiction.

F.2.7 Tornado

Location and Spatial Extent

Tornadoes occur throughout the state of North Carolina, and thus in Knightdale. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Knightdale is uniformly exposed to this hazard.

Historical Occurrences

Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there have been no recorded tornado events in Knightdale since 1956 (**Table F.14**), resulting in $0 (2013 dollars) in property damages.[8] Detailed information on these events can be found in **Table F.15**. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is likely that a number of occurrences have gone unreported over the past 50 years.

TABLE F.14: SUMMARY OF TORNADO OCCURRENCES IN KNIGHTDALE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Knightdale	0	0/0	$0

Source: National Climatic Data Center

TABLE F.15: HISTORICAL TORNADO IMPACTS IN KNIGHTDALE

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Knightdale					
None reported					

*Property Damage is reported in 2013 dollars.
Source: NCDC

2011 Tornadoes- April 16, 2011

In 2011, the county and all of its jurisdictions were impacted by one of the worst tornado-related events in the county's recorded history. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries.

[8] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Knightdale. As additional local data becomes available, this hazard profile will be amended.

Probability of Future Occurrences
According to historical information, tornado events are not an annual occurrence for the jurisdiction. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Knightdale experience a direct tornado strike. The probability of future tornado occurrences affecting Knightdale is likely (10-100 percent annual probability).

F.2.8 Winter Storm and Freeze

Location and Spatial Extent
Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Knightdale is accustomed to smaller scale severe winter weather conditions and often receives severe winter weather during the winter months. Given the atmospheric nature of the hazard, the entire jurisdiction has uniform exposure to a winter storm.

Historical Occurrences
According to the National Climatic Data Center, there have been no recorded winter storm events in Knightdale since 1993 (**Table F.16**).[9] These events resulted in $0 (2013 dollars) in damages. However, there have been 28 recorded countywide events, and most severe winter weather events are only recorded at the county level. Severe winter weather has resulted in six disaster declarations in Knightdale. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. [10]

TABLE F.16: SUMMARY OF WINTER STORM EVENTS IN KNIGHTDALE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Knightdale	0	0/0	$0

Source: National Climatic Data Center

There have been several severe winter weather events in Knightdale. The text below describes one of the major events and associated impacts on the county. Similar impacts can be expected with severe winter weather.

1996 Winter Storm
This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and

[9] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional winter storm conditions have affected Knightdale.
[10] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.

power outages. Furthermore, citizens may resort to using inappropriate heating devices that could lead to fire or an accumulation of toxic fumes.

Probability of Future Occurrences

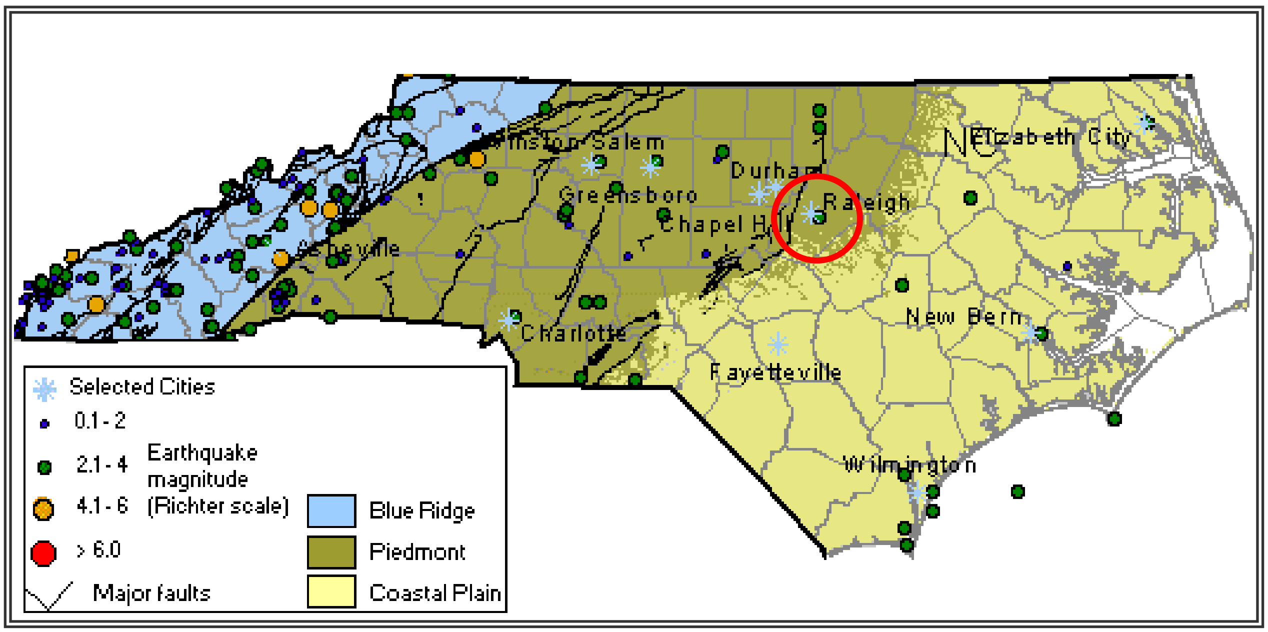
Winter storm events will remain a somewhat regular occurrence in Knightdale due to location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

F.2.9 Earthquake

Location and Spatial Extent

Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina. **Figure F.2** is a map showing geological and seismic information for North Carolina.

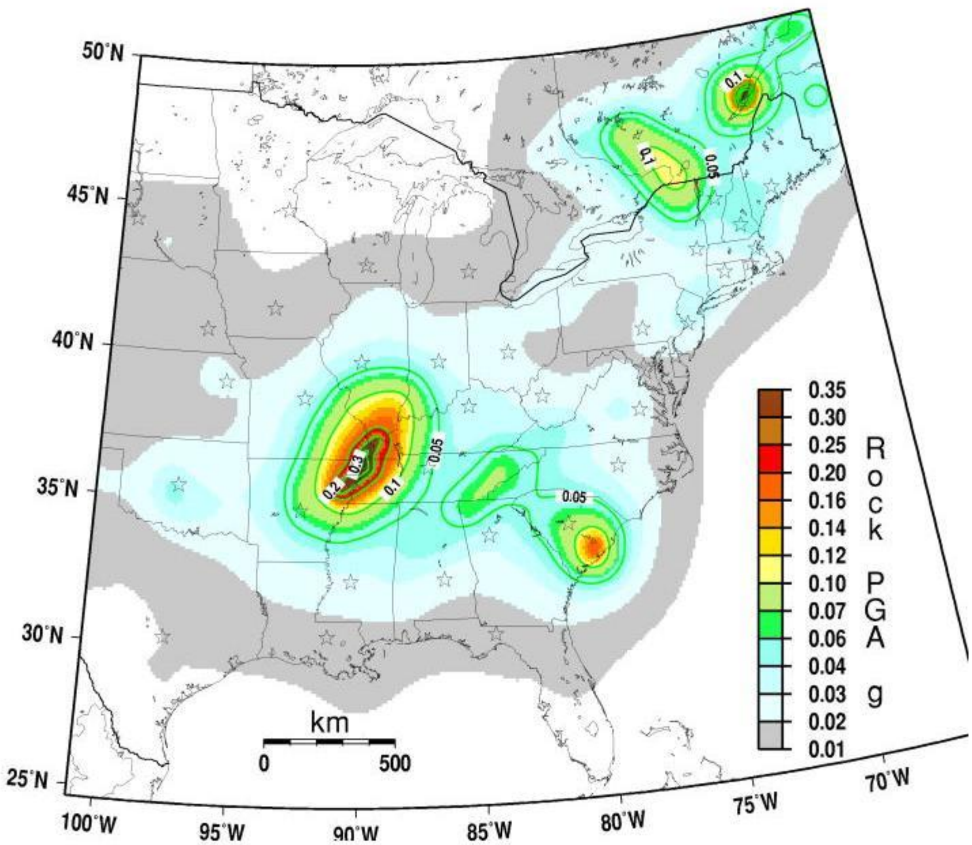
FIGURE F.2: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure F.3 shows the intensity level associated with Knightdale, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Knightdale lies within an approximate zone of level "2" to "3" ground acceleration. This indicates that the county exists within an area of moderate seismic risk.

FIGURE F.3: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

Historical Occurrences

Although no earthquakes are known to have occurred directly in Knightdale since 1874, several have occurred in the county and affected the municipality. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table F.17** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table F.18** presents a detailed occurrence of each event including the date, distance for the epicenter, and Modified Mercalli Intensity (if known). [11]

TABLE F.17: SUMMARY OF SEISMIC ACTIVITY IN KNIGHTDALE

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Knightdale	--	--	--

Source: National Geophysical Data Center

[11] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

TABLE F.18: SIGNIFICANT SEISMIC EVENTS IN KNIGHTDALE (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI (magnitude)
Knightdale				
None reported				

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Knightdale, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table F.19.**

TABLE F.19: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 - 1	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928*	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957*	Buncombe County, NC	3.7	VI	VI
11/24/1957*	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973*	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Knightdale occurrences.

** Conflicting reports on this event, intensity in North Carolina could have been either V or VI

Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Knightdale is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. The annual probability level for the county is estimated between 1 and 10 percent (possible).

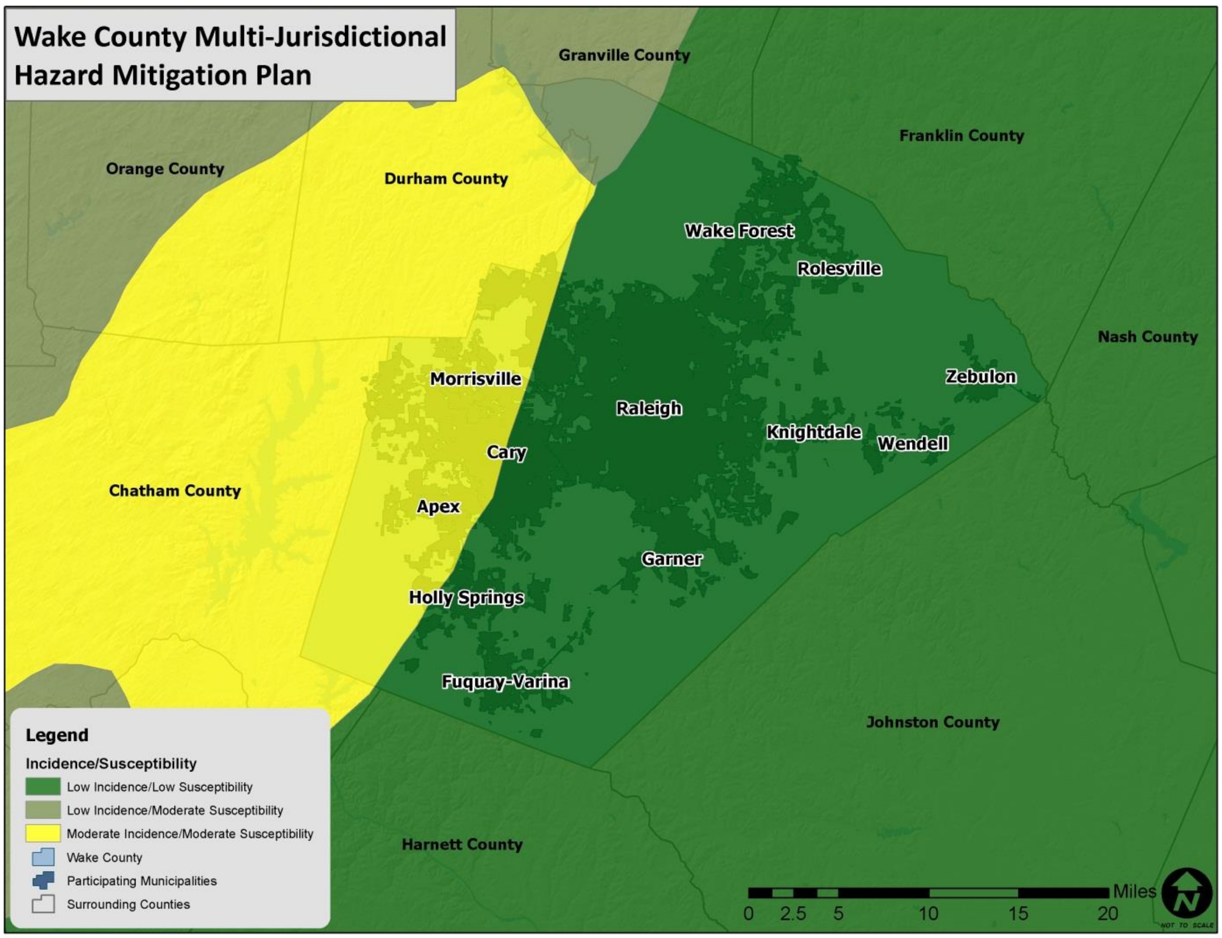
F.2.10 Landslide

Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Knightdale, although the overall risk is relatively low.

According to **Figure F.4** below, the majority of the county has low landslide activity. However there is a small area along the western border of the county that has a moderate incidence and moderate susceptibility. In all other areas (including all of Knightdale), there is low susceptibility.

FIGURE F.4: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

Historical Occurrences

Steeper topography in some areas of Knightdale make the planning area susceptible to landslides. Most landslides are caused by heavy rainfall in the area. Building on steep slopes also contributes to risk. **Table F.20** presents a summary of the landslide occurrence events as provided by the North Carolina

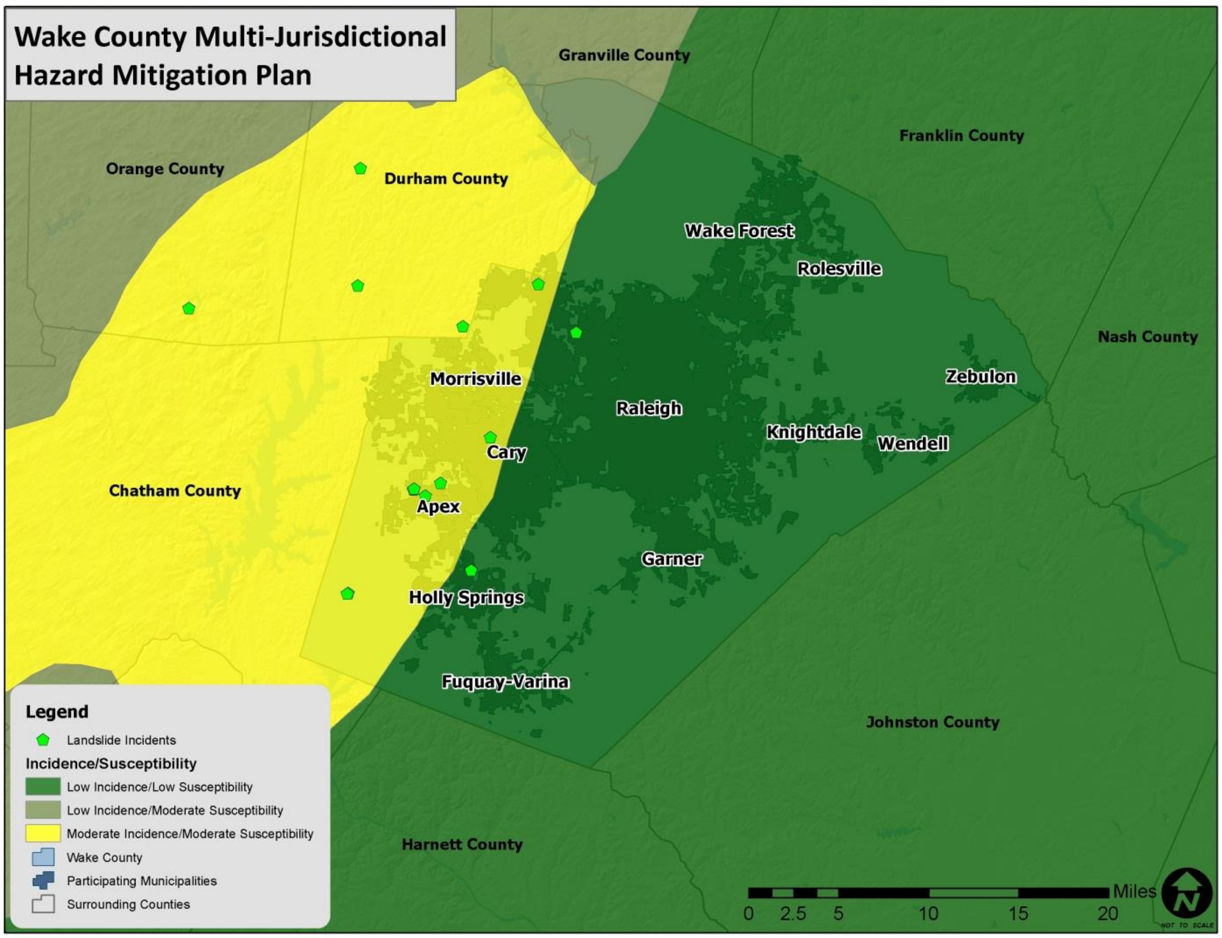
Geological Survey[12]. The georeferenced locations of the landslide events presented in the aforementioned tables are presented in **Figure F.5**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred in Knightdale.

TABLE F.20: SUMMARY OF LANDSLIDE ACTIVITY IN KNIGHTDALE

Location	Number of Occurrences
Knightdale	0

Source: North Carolina Geological Survey

FIGURE F.5: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for

[12] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Knightdale have greater risk than others given factors such as steepness on slope and modification of slopes.

F.2.11 Dam and Levee Failure

Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table F.21** explains these classifications.

TABLE F.21: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

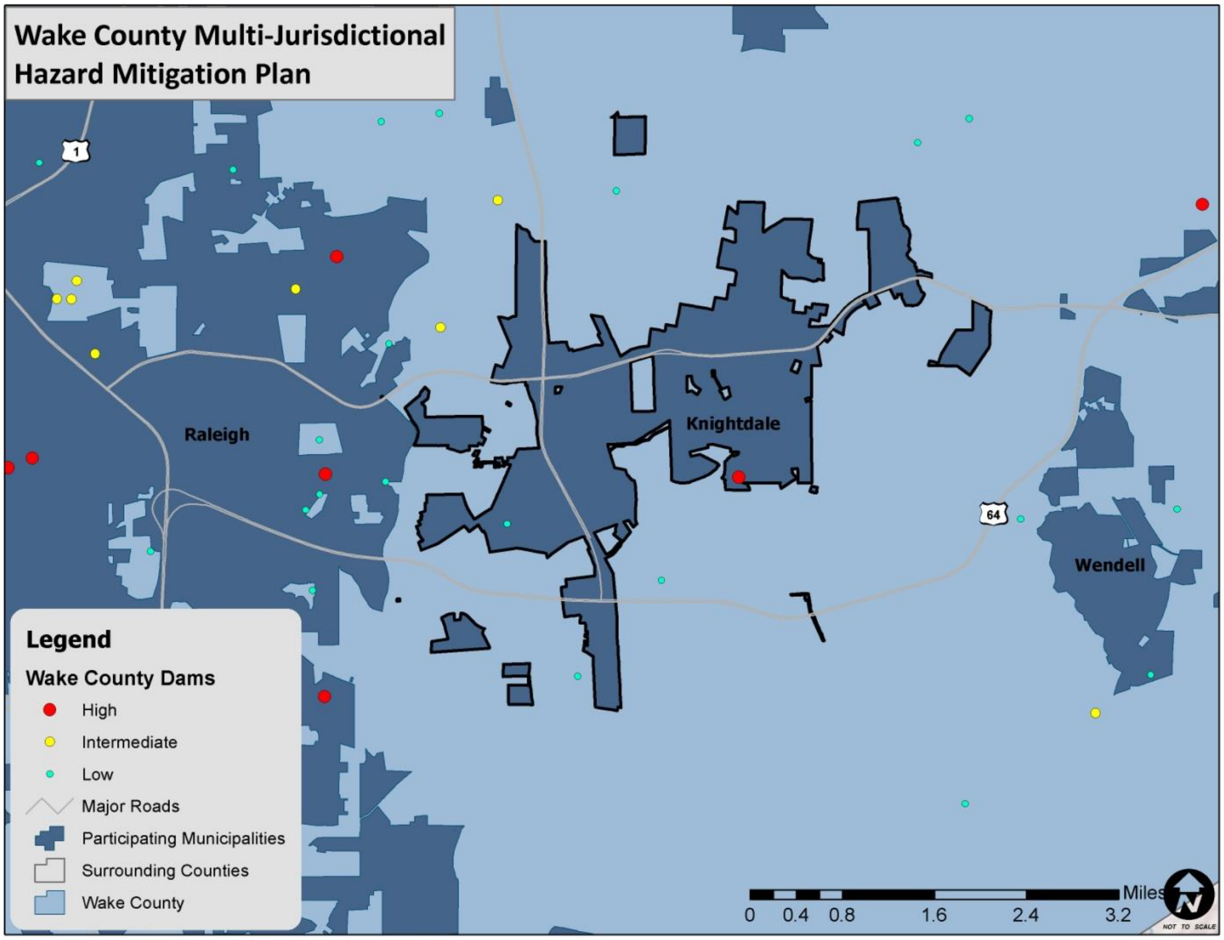
Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

According to the North Carolina Division of Land Management there are 2 dams in Knightdale.[13] **Figure F.6** shows the dam location and the corresponding hazard ranking for each. Of these dams, one is classified as high hazard potential. This high hazard dam is listed in **Table F.22**.

[13] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE F.6: KNIGHTDALE DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE F.22: KNIGHTDALE HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Knightdale				
Myrick Lake Dam	High	0	5	Private

Source: North Carolina Division of Land Resources, 2012

It should also be noted that the North Carolina dam classification regulations were recently updated. As a result of the change, more dams are generally classified as high hazard.

Historical Occurrences

No dam breaches were reported in Knightdale. However, several breach scenarios in the jurisdiction could cause substantial damage.

Probability of Future Occurrences

Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

F.2.12 Erosion

Location and Spatial Extent

Erosion in Knightdale is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Knightdale soils have greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Knightdale, particularly along the banks of rivers and streams, but it is not an extreme threat. No areas of concern were reported by the planning committee.

Historical Occurrences

Several sources were vetted to identify areas of erosion in Knightdale. This includes searching local newspapers, interviewing local officials, and reviewing the previous hazard mitigation plan. Little information could be found and erosion was not addressed in the previous Knightdale hazard mitigation plan.

Probability of Future Occurrences

Erosion remains a natural, dynamic, and continuous process for Knightdale, and it will continue to occur. The annual probability level assigned for erosion is possible (between 1 and 10 percent annually).

F.2.13 Flood

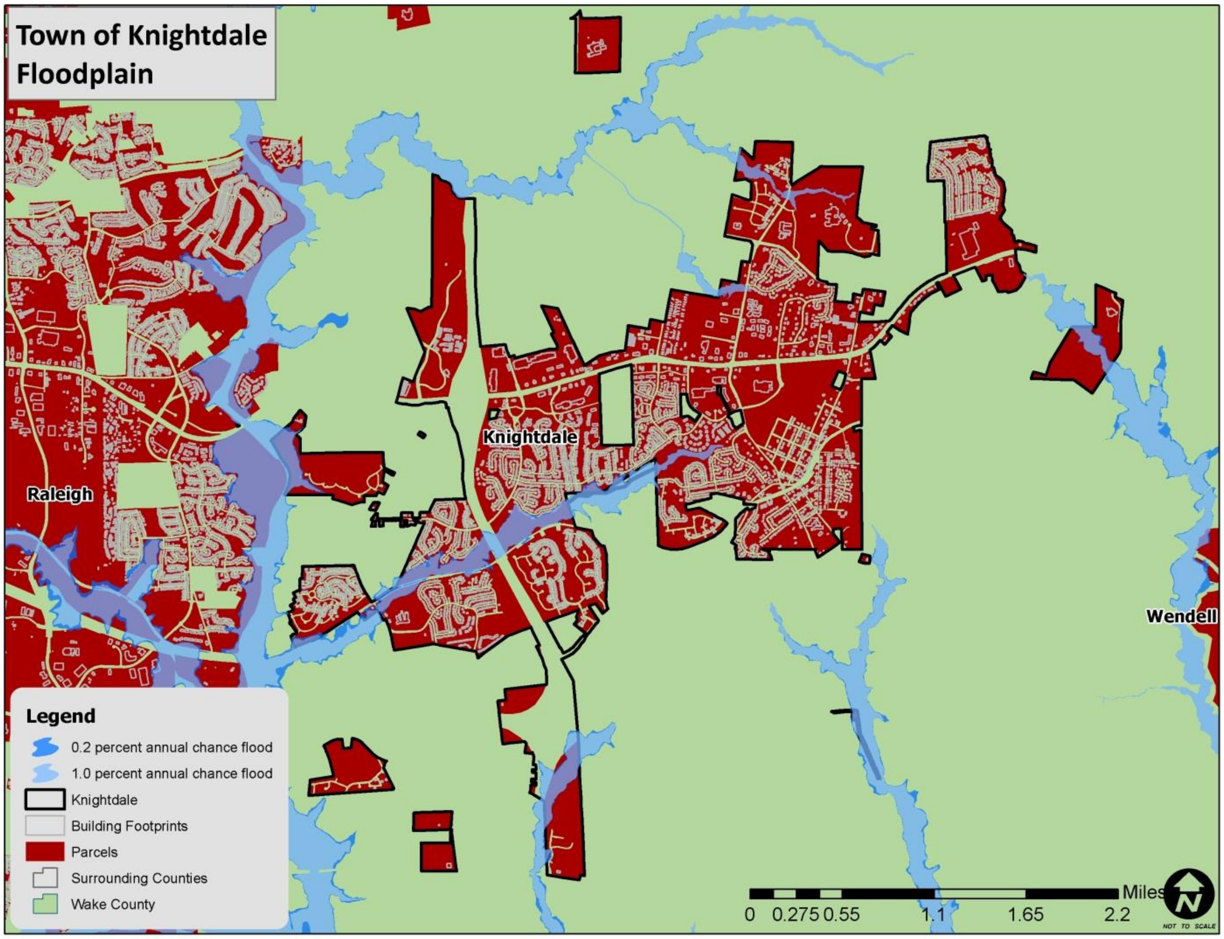
Location and Spatial Extent

There are areas in Knightdale that are susceptible to flood events. Special flood hazard areas in the jurisdiction were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[14] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), and Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 6 square miles that make up Knightdale, there are 0.31 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain).

These flood zone values account for 5.2 percent of the total land area in Knightdale. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas. **Figure F.7** illustrates the location and extent of currently mapped special flood hazard areas for Knightdale based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.

[14] The county-level DFIRM data used for Knightdale were updated in 2010.

FIGURE F.7: SPECIAL FLOOD HAZARD AREAS IN KNIGHTDALE



Source: Federal Emergency Management Agency

Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported a total of 0 events in Knightdale since 1993.[15] A summary of these events is presented in **Table F.23**. These events accounted for $0 (2013 dollars) in property damage in the town.[16] Specific information on flood events, including date, type of flooding, and deaths and injuries, can be found in **Table F.24**.

TABLE F.23: SUMMARY OF FLOOD OCCURRENCES IN KNIGHTDALE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Knightdale	0	0/0	$0

Source: National Climatic Data Center

[15] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.
[16] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

TABLE F.24: HISTORICAL FLOOD EVENTS IN KNIGHTDALE

	Date	Type	Deaths/ Injuries	Property Damage*
Knightdale				
None reported				

Source: National Climatic Data Center

Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there have been 2 flood losses reported in Knightdale through the National Flood Insurance Program (NFIP) since 1978. A summary of these figures for the jurisdiction is provided in **Table F.25**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that additional instances of flood loss in Knightdale were either uninsured, denied claims payment, or not reported.

TABLE F.25: SUMMARY OF INSURED FLOOD LOSSES IN KNIGHTDALE

Location	Flood Losses	Claims Payments
Knightdale	2	$17,361

Source: FEMA, NFIP

Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

As of July 2013, there are 0 non-mitigated repetitive loss properties located in Knightdale, which accounted for 0 losses and $0 in claims payments under the NFIP. Without mitigation, repetitive loss properties will likely continue to experience flood losses. **Table F.26** presents detailed information on repetitive loss properties and NFIP claims and policies for Knightdale.

TABLE F.26: SUMMARY OF REPETITIVE LOSS PROPERTIES IN KNIGHTDALE

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Knightdale	0	-	0	$0	$0	$0	$0

Source: National Flood Insurance Program

Probability of Future Occurrences

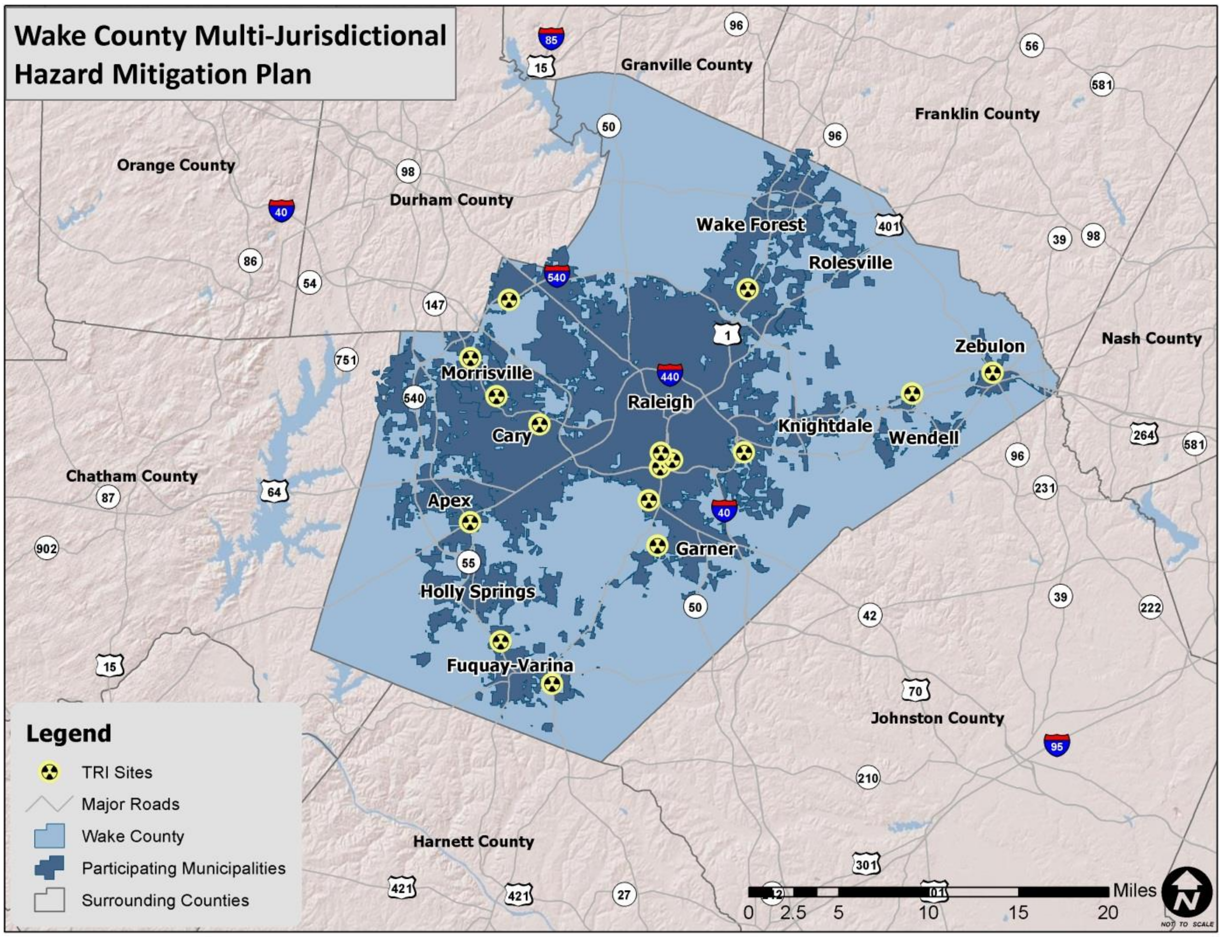
Flood events will remain a threat in areas prone to flooding in Knightdale, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability) The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above**,** which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

F.2.14 Hazardous Materials Incidents

Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Knightdale has no TRI sites as shown in **Figure F.8.**

FIGURE F.8: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the jurisdiction via roadways and rail. All roads that permit hazardous material transport are considered potentially at risk to an incident.

Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table F.27 presents detailed information on historic HAZMAT incidents reported in Knightdale.

TABLE F.27: SUMMARY OF HAZMAT INCIDENTS IN KNIGHTDALE

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Knightdale							
None reported							

Source: USDOT PHMSA

Probability of Future Occurrences

Although there are no toxic release inventory sites in Knightdale, there are several roadways and rails that transport hazardous materials, so it is possible that a hazardous material incident may occur in the jurisdiction (between 1 percent and 10 percent annual probability). Local officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

F.2.15 Wildfire

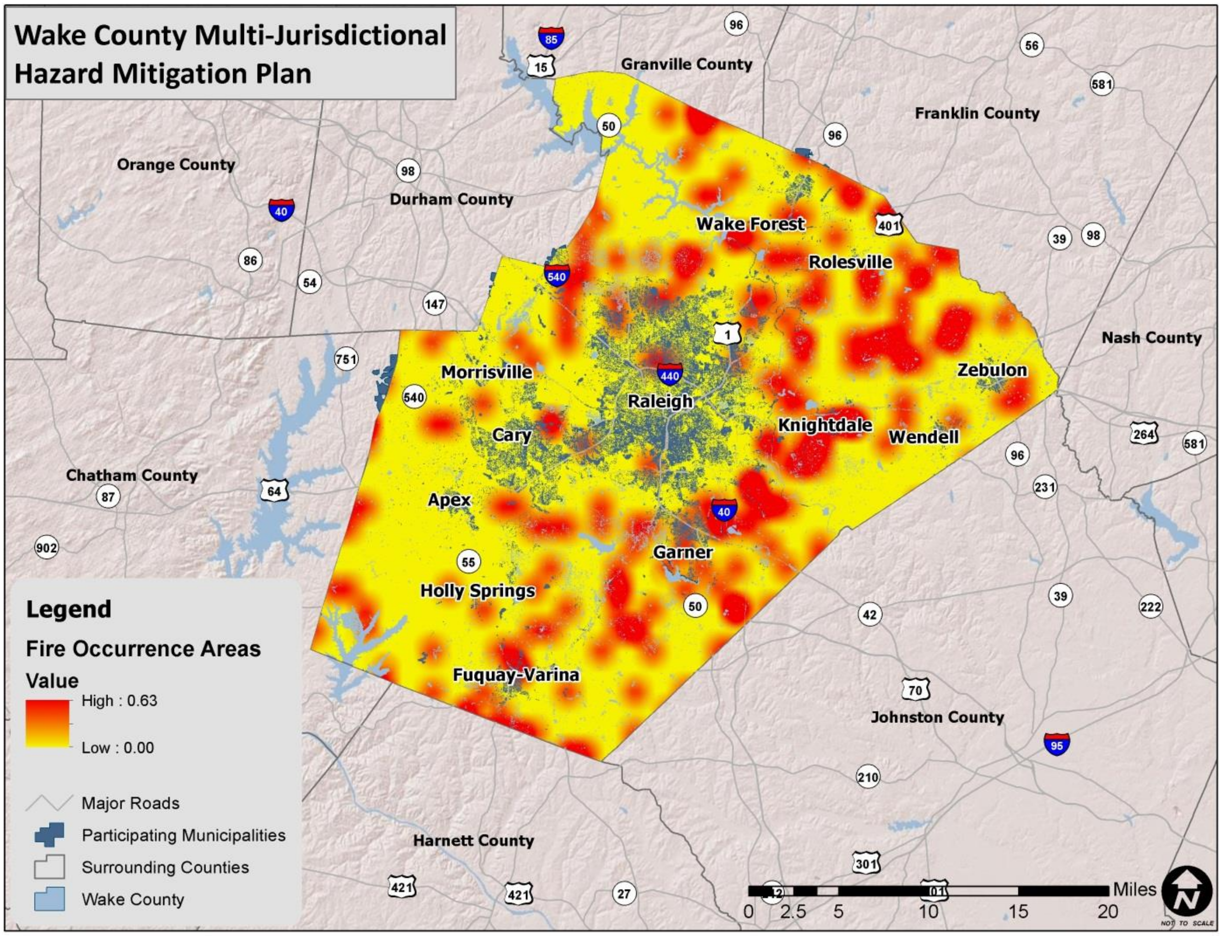
Location and Spatial Extent

The entire jurisdiction is at some risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas.

Historical Occurrences

Figure F.9 shows the Fire Occurrence Areas (FOA) in Knightdale based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. Therefore, even areas classified as at relatively high risk within the county are a relatively low risk compared to other areas of the state.

FIGURE F.9: HISTORIC WILDFIRE EVENTS IN KNIGHTDALE



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of 16 wildfires annually which burn an average of 98 acres per year. The data indicates that most of these fires are small, averaging six acres per fire. **Table F.28** lists the number of reported wildfire occurrences in the county between the years 2003 and 2012.

TABLE F.28: HISTORICAL WILDFIRE OCCURRENCES IN KNIGHTDALE

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Knightdale. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Knightdale for future wildfire events is possible (a 1 and 10 percent annual probability).

F.2.16 Nuclear Accident

Location and Spatial Extent

The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station.

Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 “Alerts” and 28 “Notice of Unusual Events” since 1986, which are shown in **Table F.29**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table F.29: SHEARON HARRIS EMERGENCY DECLARATION HISTORY

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on “B” Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).

Emergency Declaration	Date	Description
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of "A" Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - "B" diesel generator was being worked on; in accordance with test procedures, "A" diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported "Notice of Unusual Events" since 1986, which is shown in **Table F.30**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table F.30: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Probability of Future Occurrences

A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

F.2.17 Terror Threat

Location and Spatial Extent

A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table F.31** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

TABLE F.31 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food ▪ Banking and Finance ▪ Chemical ▪ Commercial Facilities ▪ Communications ▪ Critical Manufacturing ▪ Dams ▪ Defense Industrial Base ▪ Emergency Services ▪ Energy	▪ Government Facilities ▪ Healthcare and Public Health ▪ Information Technology ▪ National Monuments and Icons ▪ Nuclear Reactors, Materials, and Waste ▪ Postal and Shipping ▪ Transportation Systems ▪ Water

Historical Occurrences

Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

Probability of Future Occurrences

Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

F.2.18 Conclusions on Hazard Risk

The hazard profiles presented above were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and

experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

Hazard Extent

Table F.32 describes the extent of each natural hazard identified for Knightdale. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE F.32 EXTENT OF KNIGHTDALE HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page F:4). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Knightdale has received this ranking three times over the fourteen year reporting period.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Knightdale was 1.75 inches. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), Knightdale is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Thunderstorm Wind/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Knightdale was reported at 50 knots (approximately 58 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). Although no tornado events were recorded, a F5 is possible.
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Knightdale. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is low in Knightdale.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). Of the 2 dams in Knightdale, 1 is classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records located in Knightdale.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 5.2 percent of the total land area in Knightdale. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second.
Other Hazards	
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incident reported in the region is 75 LGA released on the highway in Raleigh. It should be noted that larger events are possible.
Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).
Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

Priority Risk Index Results

In order to draw some meaningful planning conclusions on hazard risk for Knightdale, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). More information on the PRI and how it was calculated can be found in Section 5.20.2.

Table F.33 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups and Coordinating Committee. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE F.33: SUMMARY OF PRI RESULTS FOR KNIGHTDALE

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	**2.5**
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	**2.4**
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	**2.5**
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	**2.1**
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	**3.1**
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.7**
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	**2.5**
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2**
Landslide	Unlikely	Minor	Small	Less than 6 hours	Less than 6 hours	**1.5**
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	**1.8**
Flood	Likely	Critical	Small	6 to 12 hours	Less than 1 week	**2.8**
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	**2**
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	**2.6**
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	**2.4**

F.2.16 Final Determinations on Hazard Risk

The conclusions drawn from the hazard profiling process for Knightdale, including the PRI results and input from the Regional Work Groups and Coordinating Committee, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table F.34**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Knightdale. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment* and below in Section F.3. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE F.34: CONCLUSIONS ON HAZARD RISK FOR KNIGHTDALE

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Nuclear Accident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

F.3 TOWN OF KNIGHTDALE VULNERABILITY ASSESSMENT

This subsection identifies and quantifies the vulnerability of Knightdale to the significant hazards previously identified. This includes identifying and characterizing an inventory of assets in the county and assessing the potential impact and expected amount of damages caused to these assets by each identified hazard event. More information on the methodology and data sources used to conduct this assessment can be found in Section 6: *Vulnerability Assessment*.

F.3.1 Asset Inventory

Table F.35 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for Knightdale (study area of vulnerability assessment).[17]

TABLE F.35: IMPROVED PROPERTY IN KNIGHTDALE

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Knightdale	4,700	$1,212,124,881	3,704	$885,767,979

Table F.36 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in Knightdale. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. In addition, a list of secondary facilities was created to recognize the importance of these facilities in the event of a disaster. These facilities were not mapped, but it is important to recognize that they could be impacted by nearly any of the identified hazards, especially those that are atmospheric or have no specific spatial delineation.

All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure F.10** shows the locations of the primary critical facilities in Wake County. **Table F.48**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility. As noted previously, this list is not all-inclusive and only includes information provided by the local government.

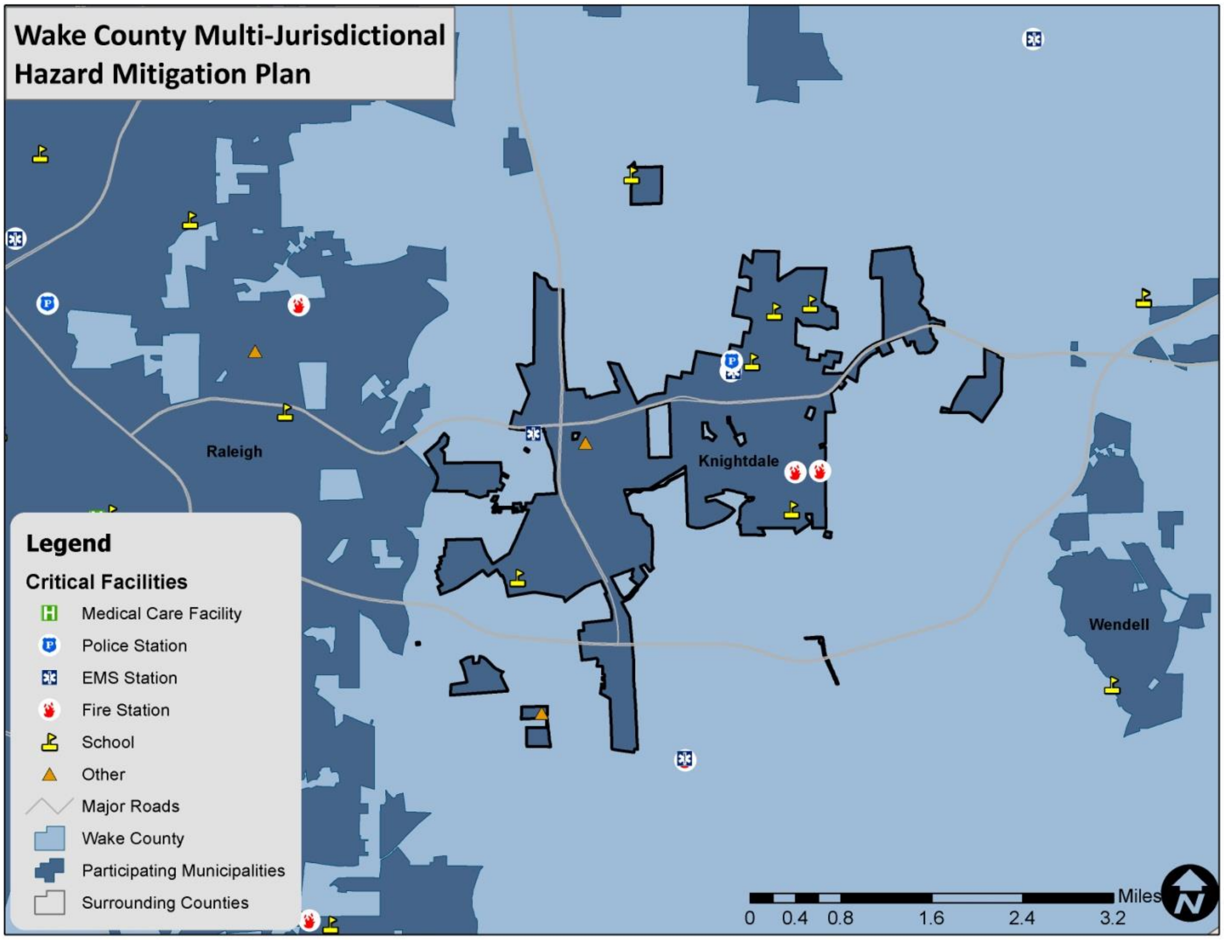
TABLE F.36: CRITICAL FACILITY INVENTORY IN KNIGHTDALE

Location	Fire Stations	Police Stations	EMS Stations	Medical Care Facilities	Schools	Other
Knightdale	3	1	1	0	6	2

Source: Local Governments

[17] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

FIGURE F.10: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: Local Governments

F.3.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Knightdale that are potentially at risk to these hazards.

Table F.37 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, limited the results to county-wide estimates. The total population in Knightdale according to Census data is 11,401 persons. Additional population estimates are presented above in Section F.1.

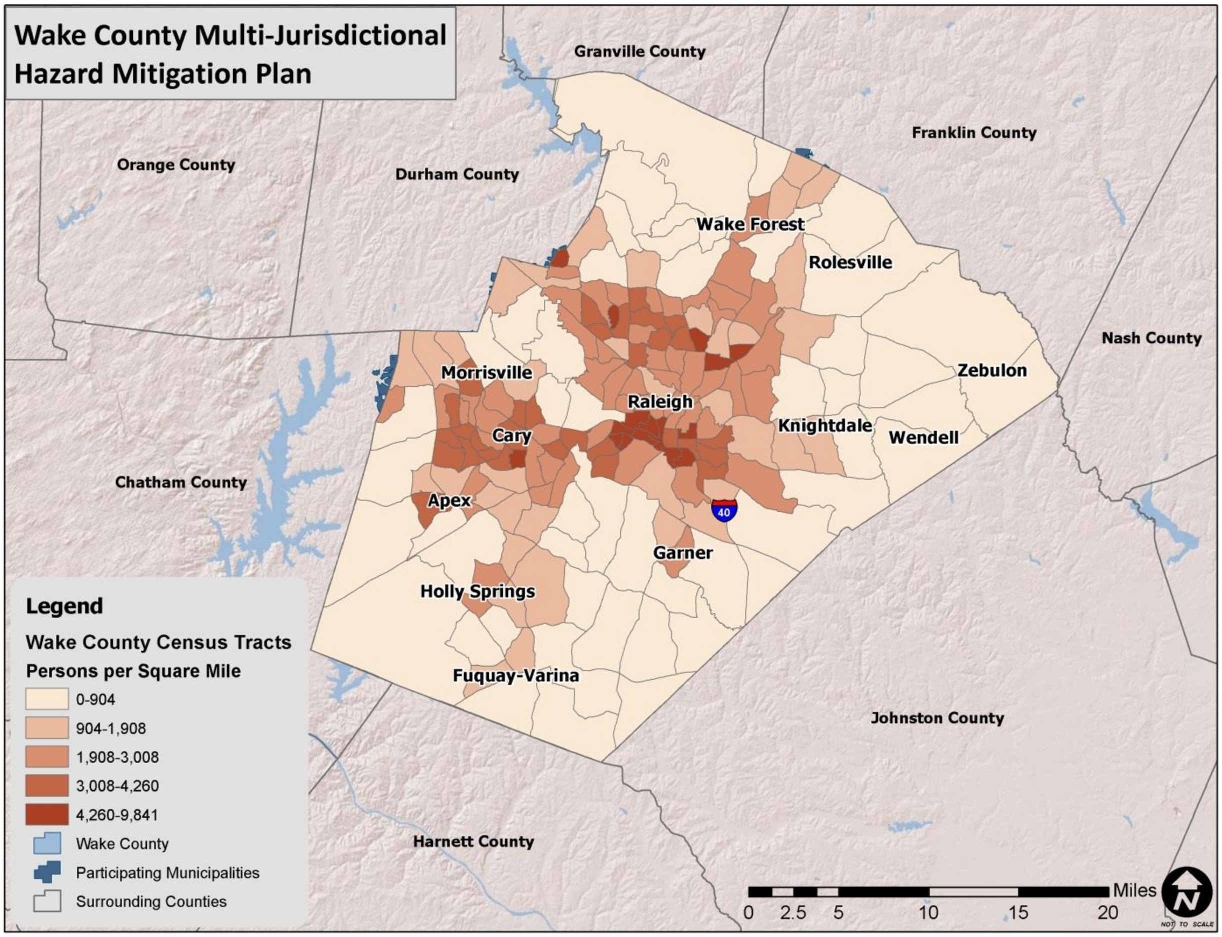
TABLE F.37: TOTAL POPULATION IN KNIGHTDALE

Location	Total 2010 Population
Knightdale	11,401

Source: U.S. Census 2010

In addition, **Figure F.11** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[18]

FIGURE F.11: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

F.3.3 Vulnerability Assessment Results

As noted in Section 6: *Vulnerability Assessment*, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results, specific to Knightdale, are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total county exposure, and thus risk, was presented in **Table F.35**.

The annualized loss estimate for all hazards is presented at the end of this section in **Table F.47.**

The hazards presented in this section include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

[18] Population by census block was not available at the time this plan was completed.

Hurricane and Tropical Storm

Historical evidence indicates that Knightdale has a significant risk to the hurricane and tropical storm hazard. Several tracks have come near or traversed through the county, as shown and discussed in Section F.2.4.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes, and high winds and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table F.38.** Only losses to buildings are reported, in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE F.38: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table F.39.**

TABLE F.39: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Knightdale	75.8	84.9	103.0	109.4

Source: Hazus-MH 2.1

Social Vulnerability

Given equal susceptibility across the county, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Knightdale, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table F.48** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Knightdale. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

Earthquake

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table F.40** summarizes the findings.

TABLE F.40: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability

It can be assumed that all existing future populations are at risk to the earthquake hazard.

Critical Facilities

The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table F.48**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Knightdale. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

Landslide

In order to complete the vulnerability assessment for landslides in Knightdale, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section F.2.10), tax parcel and building footprint data, and GIS analysis. **Table F.41** presents the potential at-risk property where available. All areas of Knightdale are identified as low incidence areas by the USGS landslide data. Since there were no high incidence levels in the county, the moderate incidence level was used to identify different areas of concern for the analysis below.

TABLE F. 41: TOTAL POTENTIAL AT-RISK PARCELS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	**Moderate**		
Knightdale	0	0	$0

Source: USGS

Social Vulnerability
Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides.

Critical Facilities
No critical facilities are located in a moderate susceptibility area. A list of specific critical facilities and their associated risk can be found in **Table F.48** at the end of this section.

In conclusion, a landslide has the potential to impact existing and future buildings, facilities, and populations in Knightdale, though some areas are at a higher risk than others due to a variety of factors. For example, steep slopes and modified slopes bear a greater risk than flat areas. Specific vulnerabilities for county assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

Flood
Historical evidence indicates that Knightdale is susceptible to flood events. No flood events have been reported by the National Climatic Data Center resulting in $0 in damages. On an annualized level, these damages amounted to $0 for Knightdale.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for the county. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table F.42** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

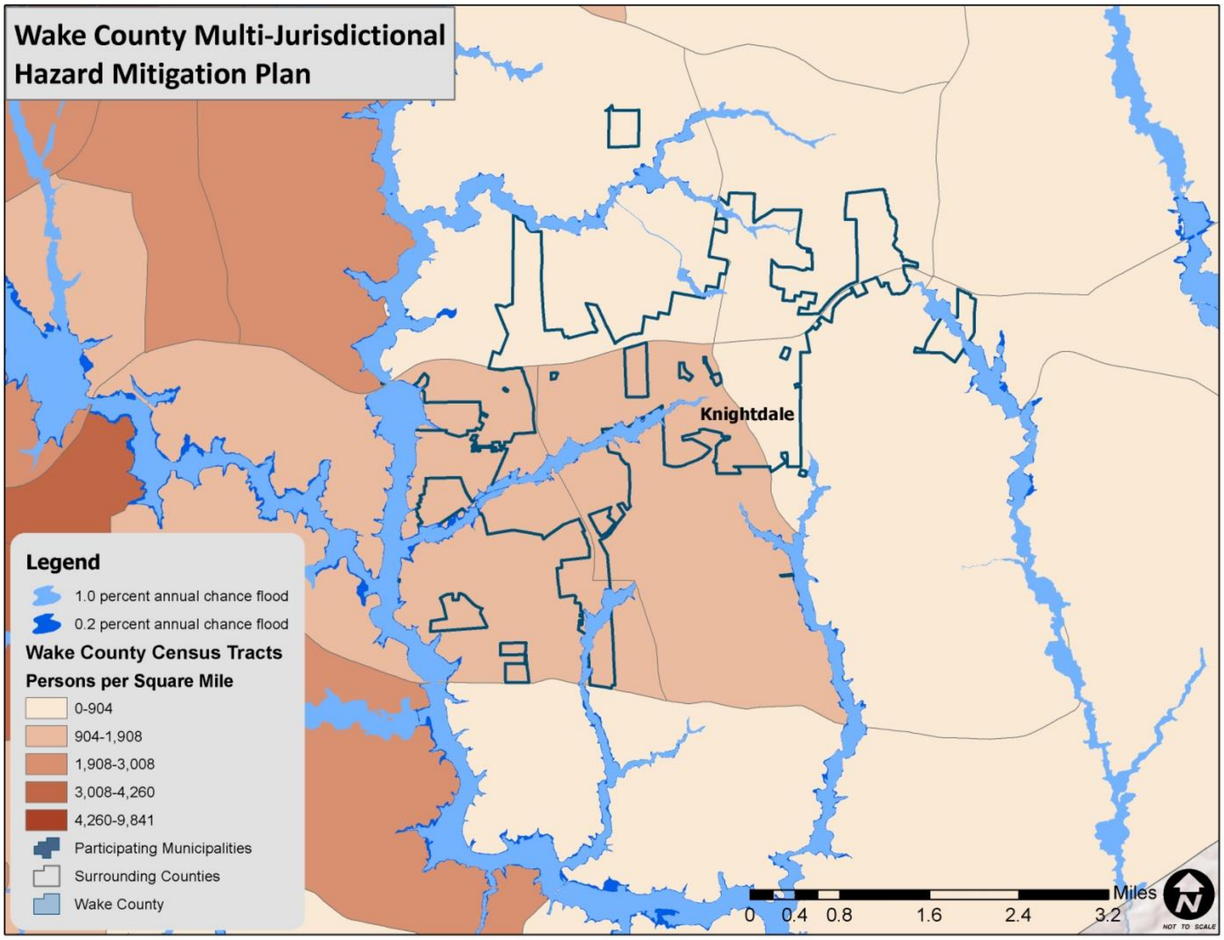
TABLE F.42: ESTIMATED EXPOSURE OF PARCELS TO THE FLOOD HAZARD

	1.0-percent ACF			0.2-percent ACF		
Location	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings
Knightdale	129	21	$47,608,720	41	20	$10,195,398

Source: FEMA DFIRM

Social Vulnerability
Since 2010 population was available at the tract level, it was difficult to determine a reliable figure on population at-risk to flood due to tract level population data. **Figure F.12** is presented to gain a better understanding of at risk population.

FIGURE F.12 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities

The critical facility analysis revealed that there are a no critical facilities located in the Knightdale 1.0-percent annual chance floodplain and 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. A list of specific critical facilities and their associated risk can be found in **Table F.48** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings and populations in Knightdale, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

Hazardous Materials Incident

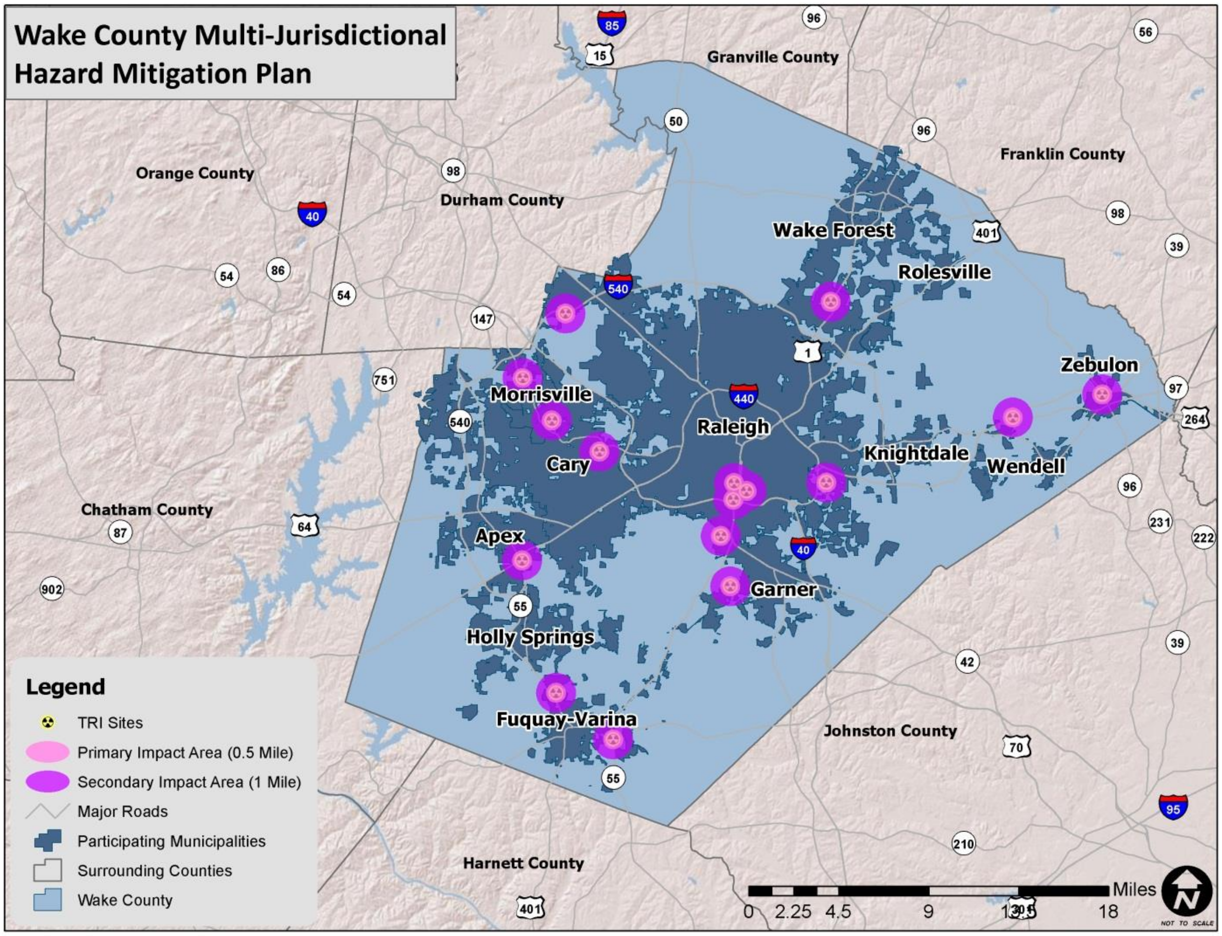
Although historical evidence and existing Toxic Release Inventory sites indicate that Knightdale is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Knightdale.

Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[19] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Knightdale, along with buffers, were used for analysis as shown in **Figure F.13.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the GIS buffer analysis. **Figure F.14** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table F.43** (fixed sites), **Table F.44** (mobile road sites) and **Table F.45** (mobile railroad sites).[20]

[19] This type of analysis will likely yield inflated results (generally higher than what is actually reported after an event).
[20] Note that parcels included in the 1.0-mile analysis are also included in the 0.5-mile analysis.

FIGURE F.13 : TRI SITES WITH BUFFERS IN KNIGHTDALE



Source: EPA

TABLE F.43: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Knightdale	0	0	$0	0	0	$0

FIGURE F.14 : MOBILE HAZMAT BUFFERS IN KNIGHTDALE

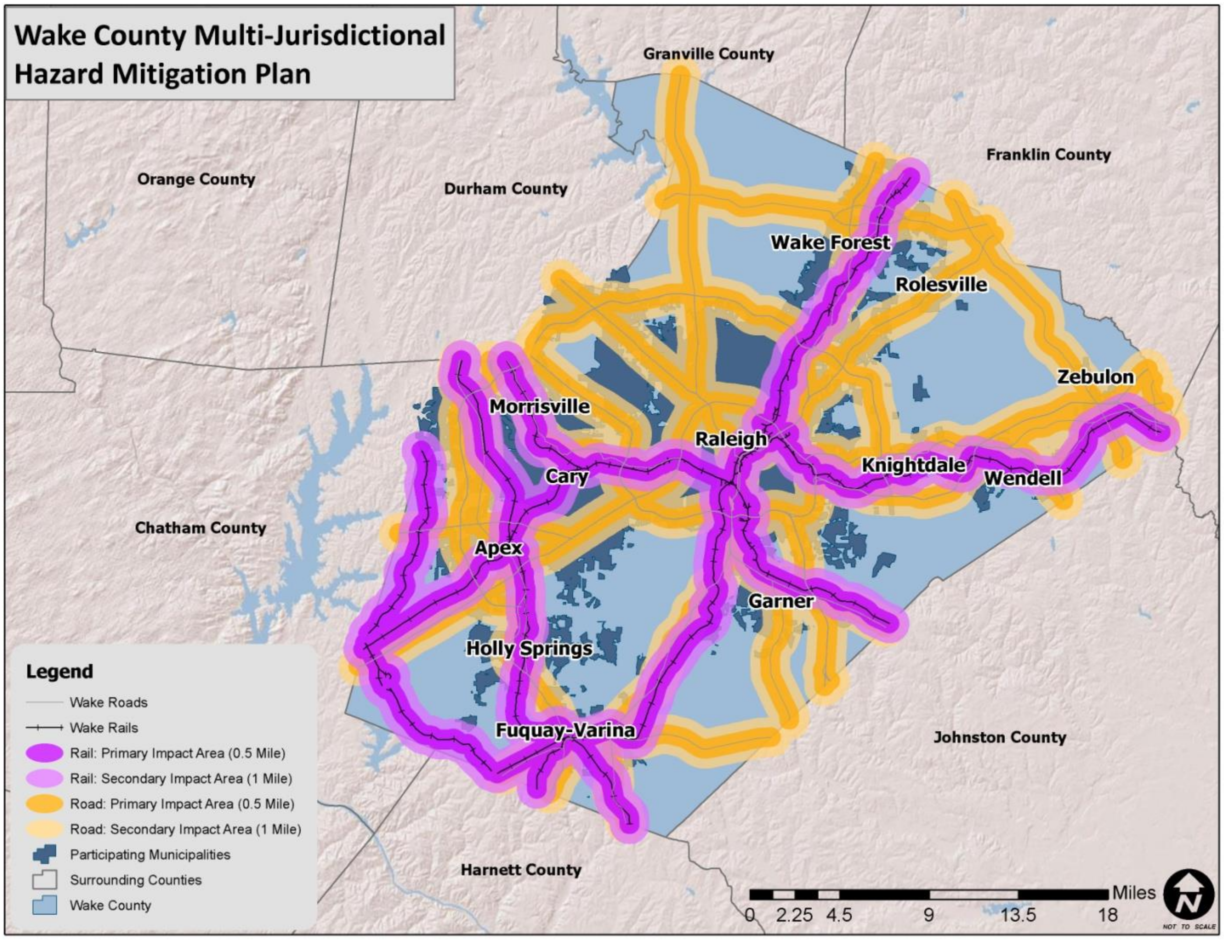


TABLE F.44: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Knightdale	3,042	2,393	$656,532,998	4,588	3,630	$867,672,937

TABLE F.45: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Knightdale	3,183	2,371	$454,248,736	3,997	3,094	$742,764,190

Social Vulnerability

Given high susceptibility across the jurisdiction, it is assumed that the total population is at risk to a hazardous materials incident. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities

Fixed Site Analysis:

The critical facility analysis for fixed TRI sites revealed that no critical facilities are located in a HAZMAT risk zone. A list of specific critical facilities and their associated risk can be found in **Table F.48** at the end of this section.

Mobile Analysis:

The critical facility analysis for road and railroad transportation corridors in Knightdale revealed that there are 13 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 5 facilities. The remaining facilities are in the secondary, 1.0-mile zone. The railroad buffer areas include 8 facilities with 4 in the primary impact zone. It should be noted that many of the facilities located in the buffer areas for railroad are also located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table F.48** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Knightdale. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc. Further, incidents from neighboring jurisdictions could also have an impact.

Wildfire

Although historical evidence indicates that Knightdale is susceptible to wildfire events, there are few reports of damage. Upon conversion of the wildfire risk data (see Section 6: *Vulnerability Assessment*) and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the jurisdiction should be assumed to be very low. As such, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the county.

Social Vulnerability

All areas have relatively equal vulnerability and there is low susceptibility across the entire county.
It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in wildfire areas of concern. It should be noted, however, that several factors could impact the spread of a wildfire putting all facilities at risk. A list of specific critical facilities and their associated risk can be found in **Table F.48** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Knightdale.

Nuclear Accident

The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table F.46** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE F.46: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[21]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[22]
Knightdale	0	0	$0	4,700	3,704	$885,767,979

Social Vulnerability

Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in the 10-mile nuclear buffer area.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in Knightdale, though areas closer to the power plant are at a higher risk than others. All structures are at some risk given that they are all located within at least the 50-mile buffer area.

Conclusions on Hazard Vulnerability

Table F.47 presents a summary of annualized loss for each hazard in Knightdale. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, although an annualized loss was determined through the damage reported through historical occurrences at the municipal level, it is likely that the county-wide

[21] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.
[22] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

estimate (found in Section 6: *Vulnerability Assessment*) is potentially a better estimate. These values should be used as an additional planning tool or measure risk for determining hazard mitigation strategies.

TABLE F.47: ANNUALIZED LOSS FOR KNIGHTDALE*

Event	Knightdale
Dam Failure	Negligible
Drought	Negligible
Erosion	Negligible
Extreme Heat	Negligible
Hail	Negligible
Hurricane & Tropical Storm	Negligible
Landslide	Negligible
Lightning	$1,407
Thunderstorm Wind/High Wind[23]	$375
Tornado	Negligible
Winter Storm & Freeze	Negligible
Flood	Negligible
Earthquake	Negligible
HAZMAT Incident	Negligible
Wildfire	Negligible
Nuclear Accident	Negligible
Terror Threat	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table F.48** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

[23] The annualized losses for these hazards were combined.

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TABLE F.48: AT-RISK CRITICAL FACILITIES IN KNIGHTDALE

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
KNIGHTDALE																								
KNIGHTDALE MAIN	EMS STATION	X	X	X	X	X	X	X	X	X							X	X		X			X	X
EASTERN WAKE #2	FIRE STATION	X	X	X	X	X	X	X	X	X								X	X	X			X	X
KNIGHTDALE PUB SAFETY #2	FIRE STATION	X	X	X	X	X	X	X	X	X								X	X	X			X	X
KNIGHTDALE PUB SAFETY #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X		X			X	X
CARILLON ASSISTED LIVING	OTHER	X	X	X	X	X	X	X	X	X								X					X	X
WELLINGTON NURSING HOME	OTHER	X	X	X	X	X	X	X	X	X							X	X		X			X	X
KNIGHTDALE	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
LOCKHART ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X		X			X	X
EAST WAKE MS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
KNIGHTDALE ES	SCHOOL	X	X	X	X	X	X	X	X	X								X	X	X			X	X
KNIGHTDALE HS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
FORESTVILLE ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
HODGE ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X								X	X	X			X	X

Secondary Critical Facilities are listed in slight contrast to Critical Facilities as their continued function has not been deemed as critical as primary facilities in the event of a disaster, but these facilities are extremely important. A loss of function to one of these facilities would have a definitively greater negative impact on the community's ability to respond to and recover from a disaster than a loss of function at other facilities/structures within the jurisdiction. In **Table F.49**, these facilities have been classified as either Significant Community Locations/Sheltering Centers or as Critical Resources Management Facilities. These facilities are all vulnerable to any of the atmospheric hazards and many are also likely vulnerable to other hazards identified above, though no locational analysis was carried out to this end.

TABLE F.49: KNIGHTDALE SECONDARY CRITICAL FACILITIES

Facility Name	Address*	Type
Knightdale		
Recreation Center	101 Lawson Rd	Significant Community Location or Sheltering Center
Old Town Recreation Center	426 N. First Ave	Significant Community Location or Sheltering Center
Track Out Camp at Harper Park	209 Main Street	Significant Community Location or Sheltering Center
Knightdale Swim Club Clubhouse	202 Milburnie Rd	Significant Community Location or Sheltering Center
0.5 MGD Water Tank	7429 Knightdale Blvd	Critical Resources Management (Energy, Water, etc.)
1.0 MDG Water Tank	2126 Hodge Road	Critical Resources Management (Energy, Water, etc.)
Water Booster Pump Stations	• Knightdale Blvd • Forestville Blvd	Critical Resources Management (Energy, Water, etc.)
Sanitary Sewer Pump Stations	• Poole Rd/Neuse • Poplar Cr. Village • Square D • Town Hall • Harper St • Oakwood Acres • Poole Rd/Poplar Cr • Langston Ridge (proposed)	Critical Resources Management (Energy, Water, etc.)
Gas Feeder Line	Knightdale Blvd	Critical Resources Management (Energy, Water, etc.)
Bell South Building	100 Forest Drive	Critical Resources Management (Energy, Water, etc.)
East Wake Library	946 Steeple Square Court	Significant Community Location or Sheltering Center
Angelica's Childcare Center	1305 Oak Crest Drive	Significant Community Location or Sheltering Center
Cathy Lee Child Development Center	529 Bethlehem Road	Significant Community Location or Sheltering Center
Cora's Caring Hands	106 Thomas Place	Significant Community Location or Sheltering Center
Forestville Elementary Before/After School Care	100 Lawson Ridge Road	Significant Community Location or Sheltering Center
Grow-N-Learn Child Care Center	1002 Mulford Court	Significant Community Location or Sheltering Center
Hodge Rd Elementary Before and After School Program	2129 Mingo Bluff Blvd	Significant Community Location or Sheltering Center
Jenette's Quality Care	111 Satterwhite Drive	Significant Community Location or Sheltering Center
Kid's Palace Home Child Care	942 Widewaters Parkway	Significant Community Location or Sheltering Center

Facility Name	Address*	Type
Kids Educational Center IV, Inc.	7106 Forestville Road	Significant Community Location or Sheltering Center
Kids Educational Center	4605 Old Faison Road	Significant Community Location or Sheltering Center
Kindercare Learning Centers LLC	200 Forest Dr	Significant Community Location or Sheltering Center
Knightdale Christian Childcare Center	7114 Knightdale Blvd, Suite A	Significant Community Location or Sheltering Center
Ma Ma Jo's Day Care	301 Park Ave	Significant Community Location or Sheltering Center
Pride and Joy Day Care	1209 Shakentown St.	Significant Community Location or Sheltering Center
Showers of Blessings Childcare	5116 Dantonville Ct.	Significant Community Location or Sheltering Center
The Growing Child Unlimited, Inc.	1005 Big Oak Court	Significant Community Location or Sheltering Center
Widewaters Learning Center	9565 Village Park Dr.	Significant Community Location or Sheltering Center
N.G. House Store	221 N. First Ave	Significant Community Location or Sheltering Center
Henry H. Knight Farm	7045 Knightdale Blvd	Significant Community Location or Sheltering Center
Midway Plantation	1900 Amethyst Ridge Drive	Significant Community Location or Sheltering Center
Beaver Dam Plantation	7081 Forestville Rd	Significant Community Location or Sheltering Center

**Some address information could not be provided or was not applicable to the facility*

F.4 TOWN OF KNIGHTDALE CAPABILITY ASSESSMENT

This subsection discusses the capability of the Town of Knightdale to implement hazard mitigation activities. More information on the purpose and methodology used to conduct the assessment can be found in Section 7: *Capability Assessment*.

F.4.1 Planning and Regulatory Capability

Table F.50 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the Town of Knightdale. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE F.50: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning Tool/Regulatory Tool	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan (Parks & Rec/Greenway Plan	Stormwater Management Plan/Ordinance	Natural Resource Protection Plan	Flood Response Plan	Emergency Operations Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	National Flood Insurance Program (NFIP)	NFIP Community Rating System
Knightdale	✓	✓		✓	✓			✓				✓			✓	✓	✓	✓		✓	✓	✓	

A more detailed discussion on the town's planning and regulatory capabilities follows.

Emergency Management

Hazard Mitigation Plan
The Town of Knightdale has previously adopted a hazard mitigation plan.

Emergency Operations Plan
The Town of Knightdale has adopted the Wake County Emergency Operations Plan. The town also maintains a municipal-level emergency operations plan.

General Planning

Comprehensive Land Use Plan
The Town of Knightdale has adopted a Comprehensive Plan.

Capital Improvements Plan
The Town of Knightdale adopts an annual capital improvement plan.

Zoning Ordinance
The Town of Knightdale includes zoning regulations as part of the local unified development ordinance.

Subdivision Ordinance
The Town of Knightdale also includes subdivision regulations as part of the local unified development ordinance.

Building Codes, Permitting, and Inspections
North Carolina has a state compulsory building code which applies throughout the state. Wake County provides building inspections through contractual agreement for the Town of Knightdale.

Floodplain Management

Table F.51 provides NFIP policy and claim information for the Town of Knightdale.

TABLE F.51: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
Knightdale	08/01/78	04/16/07	35	$8,640,800	2	$17,361

Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Flood Damage Prevention Ordinance
All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. The Town of Knightdale participates in the NFIP and has adopted flood damage prevention regulations.

Open Space Management Plan
The Town of Knightdale has adopted a parks, recreation, and open space master plan.

Stormwater Management Plan
The Town of Knightdale has not adopted a stormwater management plan; however, the town includes stormwater management regulations as part of the local unified development ordinance.

F.4.2 Administrative and Technical Capability

Table F.52 provides a summary of the capability assessment results for the Town of Knightdale with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in the town with the specified knowledge or skill.

TABLE F.52: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	Planners with knowledge of land development/land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency Manager	Floodplain Manager	Land Surveyors	Scientists familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Resource development staff or grant writers
Knightdale	✓	✓	✓	✓	✓		✓	✓	✓	✓

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

F.4.3 Fiscal Capability

Table F.53 provides a summary of the results for the Town of Knightdale with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plan.

TABLE F.53: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes (or taxing districts)	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.
Knightdale	✓	✓	✓			✓	✓	✓	✓	✓

F.4.4 Political Capability

The Town of Knightdale is very supportive of mitigation efforts. This support is evident from the elected officials, the residents of the town, and the developers who are helping the town grow. All parties understand the importance of development in a manner that respects the natural constraints that exist and the role the town plays in ensuring that future development remain at a low risk from possible disasters. The attitude toward mitigation measures is expected to continue in the future, even as mayors and council members change.

F.4.5 Conclusions on Local Capability

Table F.54 shows the results of the capability assessment using the designed scoring methodology described in Section 7: *Capability Assessment*. The capability score is based solely on the information found in the existing hazard mitigation plan and readily available on the town's government website. According to the assessment, the local capability score for the town is 44, which falls into the high capability ranking.

TABLE F.54: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
Knightdale	44	High

F.5 TOWN OF KNIGHTDALE MITIGATION STRATEGY

This subsection provides the blueprint for Knightdale to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Regional Work Groups and the findings and conclusions of the capability assessment and risk assessment. Additional Information can be found in Section 8: *Mitigation Strategy* and Section 9: *Mitigation Action Plan*.

F.5.1 Mitigation Goals

Knightdale developed seven mitigation goals in coordination with Wake County and the other participating municipalities. The county-wide mitigation goals are presented in **Table F.55**.

TABLE F.55: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

F.5.2 Mitigation Action Plan

The mitigation actions proposed by Knightdale are listed in the following Mitigation Action Plan.

Town of Knightdale Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Adopt Hazard Mitigation Plan & Updates.	All	High	Knightdale Town Council	Internal, HGMP	Upon approval by FEMA	Town Council adopted Plan Update by resolution on 8/19/2009. This update to be adopted pending approval.
P-2	Prepare Plan Maintenance Report.	All	High	Knightdale Planning	Internal	2015, Annually and update	Plan maintenance meetings have been held three of the five years since the last update.
P-3	Prepare updates to Plan.	All	High	Knightdale Planning & Advisory Committee	Internal	2015, Annually and update	No updates have been found necessary to make outside the 5-year update process.
P-4	Revise Hazard Mitigation Plan.	All	High	Knightdale Planning & Advisory Committee	Internal	2014, Every 5 years	Knightdale is actively participating in the county-led process to consolidate all Wake County jurisdictional plans.
P-5	Keep evacuation routes open.	All	High	Knightdale Public Works &Public Safety	Internal	Completed	Knightdale Public Works crews coordinate work with NCDOT and have spread salt and brine and plowed streets during winter storms, and Public Safety personnel keep traffic moving around temporary hazards and through temporarily unsignalled intersections. This action will be removed in the next update as a capability.
P-6	Maintain water supply system, including generators at booster plant	All	High	City of Raleigh Public Utilities	Internal	Completed	City of Raleigh Public Utility crews provide system maintenance per routine schedules. Verify This action will be removed in the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-7	Maintain sewer lift stations, including generators.	All	High	City of Raleigh Public Utilities	Internal	Completed	City of Raleigh Public Utility crews provide system maintenance per routine schedules. Verify This action will be removed in the next update as a capability..
P-8	Update Emergency Response Plan.	All	High	Knightdale Public Safety	Internal	2019	Completed, The most recent version of the Knightdale EOP was adopted by the Town Council on March 4, 2013. The town will need to review and update the EOP going forward so this action will remain in the plan.
P-9	Enforce UDO standards for development in flood hazard areas.	Flood	High	Knightdale Planning and Inspections	Internal	Completed	Knightdale Planning Department staff enforces these standards as part of the regular development approval process. This action will be removed in the next update as a capability.
P-10	Prohibit development less than two (2) feet above BFE.	Flood	High	Knightdale Planning	Internal	Completed	Knightdale Planning Department staff enforces this standard as part of the regular development approval process and permit checklists. This action will be removed in the next update as a capability.
P-11	Complete stormwater management plan and institute stormwater management program.	Flood	High	Knightdale Public Works and Engineering	Internal, FEMA, NCEM	Completed	Completed. Knightdale's Phase II permit was renewed on 12/1/2011. Budget and stormwater utility billing were instituted on July 1, 2012.
P-12	Pursue Grants to Acquire, Elevate and or Relocate Flood Prone Structures and Property.	Flood	High	Knightdale Planning	Internal	As needed when funding is available, 2019	This has not been necessary sine there have been no affected structures and/or property.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-13	Require floodproofing and/or removal of structures requesting substantial improvement.	Flood	High	Knightdale Planning and Inspections	Internal	Completed	Revised. This has not been necessary since there have been no requests, but the Town Engineer monitors this through the Town's floodplain development permitting process and inspects property prior to issuance of a CO. This action will be removed in the next update as a capability.
P-14	Maintain list of all structures located within the floodplain.	Flood	High	Knightdale Planning	Internal	Completed	Completed. As of February 2012, the Town maintains the FEMA floodplain maps and impervious surface areas such as building footprints within its GIS system.
P-15	Require burial of power lines for new developments.	Hurricanes, Tornadoes, Winter Storms/ Freezes	Moderate	Knightdale Planning	Private	Completed	Per the Town's UDO, power lines along new streets are required to be placed underground. This standard is enforced through development review and permitting processes. This action will be removed in the next update as a capability.
P-16	Require new construction to comply with wind section of Building Code.	Hurricanes, Tornadoes	High	Knightdale Inspections	Internal	Completed	Inspectors for Knightdale require compliance with the Code through the building permit process. This action will be removed in the next update as a capability.
P-17	Establish post-disaster clean-up procedures.	Hurricanes, Tornadoes, Winter Storms/ Freezes	High	Knightdale Public Works	Internal	Fall 2014	In progress. Rather than set up its own procedures, Knightdale is working with Wake County to piggyback on theirs, and it is expected to be finalized sometime during Spring 2014.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-18	Prepare debris removal and disposal plan.	Hurricanes, Tornadoes, Winter Storms/ Freezes	Moderate	Knightdale Public Works	Internal, FEMA, NCEM	Fall 2014	In progress. Public Works employees and temporarily contracted workers currently oversee debris removal and disposal. This will also be part of the joint procedures and plans with Wake County that will be finalized during Spring 2014.
P-19	Complete the Dempsey E. Benton Water Treatment Plant.	Drought	High	City of Raleigh Public Utilities	Internal	Completed	Completed. City of Raleigh Public Utilities completed and opened the Benton WTP in May 2010.
P-20	Protect and Obtain Land for the Little River Reservoir.	Drought	Moderate	City of Raleigh Public Utilities	Internal	2019	In progress. City of Raleigh has completed the purchase of land necessary for the future construction of the reservoir but the reservoir has not been built.
Public Education and Awareness							
PEA-1	Distribute “Ready Wake” brochures in libraries, Town Hall, public places and on the Town Web Site.	All	Moderate	Knightdale Communications Director	Internal	2015	Knightdale hired a Communications Director in 2013 to oversee these efforts. That office monitors brochure availability with assistance from Parks and Recreation Department and will work to distribute public information via a number of channels.
PEA-2	Inform public of construction requirements in hazard areas.	All	Moderate	Knightdale Building/ Inspections	Internal	Completed	Brochures are maintained and made available to the public and clients are advised by inspectors during the building permit process. This action will be removed in the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-3	Require disclosure of flood hazard in real estate transactions.	Flood	Moderate	Knightdale Planning	Internal	Completed	Planning staff ensure flood hazards are shown on recorded plats through the development review process and permitting checklists. This action will be removed in the next update as a capability.
PEA-4	Present Plan at public meeting.	All	Moderate	Knightdale Planning	Internal, HMGP	2014	In progress. There has been no plan update to present since 2009; however, updates will be presented as part of the new updates process in 2014.
PEA-5	Post plan maintenance report for public comment.	All	Moderate	Knightdale Communications Director	Internal	Completed	Knightdale hired a Communications Director in 2013 to oversee these efforts. To date, no formal reports have been produced from the three update meetings due to lack of significant updates. This action will be removed in the next update as a capability.
PEA-6	Post copy of Plan on website, in Town Hall.	All	Moderate	Knightdale Communications Director	Internal	Upon approval by FEMA	Knightdale hired a Communications Director in 2013 to oversee these efforts; however, the Planning Department posted the 2009 plan to the Town website following its adoption on 8/19/09. This action will be removed in the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-7	Monitor areas known to flood. Directly contact affected property owners by phone or in person.	Flood	Low	Knightdale Engineering and Public Works	Internal	Completed	Engineering and Public Works staff monitor stormwater channels following locally significant events and make needed improvements via the new stormwater utility fund. This action will be removed in the next update as a capability.
PEA-8	Make flood maps available to the public.	Flood	Moderate	Knightdale Planning	Internal	Completed	Knightdale Planning staff work with Wake County and City of Raleigh GIS departments to make maps available through the online "iMaps" application. Planning staff also maintain printed copies for local public inspection. This action will be removed in the next update as a capability.
PEA-9	Distribute "Ready Wake" storm preparation brochures and post on the Town website.	Hurricane	Low	Knightdale Administration	Internal	Deleted	Deleted. Duplicate of PEA-1.
PEA-10	Utilize electronic newsletter to keep citizens informed.	All	Low	Knightdale Communications Director	Internal	2015	Knightdale hired a Communications Director in 2013 to oversee these efforts. The Town's new website Content Management System has various mass communication methods including email blasts and emergency information pop-ups.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-11	Keep website updated with latest storm and emergency response information.	All	Low	Knightdale Communications Director	Internal	Completed	Knightdale hired a Communications Director in 2013 to oversee these efforts. The Town's new website Content Management System has various mass communication methods including email blasts and emergency information pop-ups. This action will be removed in the next update as a capability.
PEA-12	Keep website updated with latest information on drought, water restrictions and water conservation techniques.	Drought	Low	Knightdale Communications Director	Internal	Completed	Knightdale hired a Communications Director in 2013 to oversee these efforts. The Town's new website Content Management System has various mass communication methods including email blasts and emergency information pop-ups. This action will be removed in the next update as a capability.
PEA-13	Develop a policy for the installation of warning signs concerning lightning, hail and thunderstorms at outdoor public facilities and begin retro-fitting existing spaces.	Hail and Lightning	Moderate	Knightdale Parks & Recreation	Internal	2017 – Adopt Policy 2020 – Complete retrofit of existing facilities	New strategy.
PEA-14	Improve drought monitoring and communication of data to the public by relying less on state and regional data and establishing a local source.	Drought	Low	Knightdale Communications Director	Internal, Grants, Local TV Partnership	2019 – Install local weather gauges near Town Hall 2020 – Make daily readings available to the public	New strategy.
PEA-15	Expand the Town's existing fire/smoke alarm program for retro-fitting older structures to include CO alarms.	Winter Storms/ Freezes	Low	Knightdale Fire	Internal, Grants	2016 – Update program guidelines, alarm specifications and policies	New strategy.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-16	Have a Town staff member that is a Certified Floodplain Manager.	Flood	Moderate	Knightdale Engineering/Public Works	Internal	2018 – Staff member certified	New strategy.
PEA-17	Issue an annual local proclamation for Severe Weather Awareness Week and conduct associated promotional activities.	All	Moderate	Knightdale Fire	Internal	March, 2016 – Hold first annual event	New strategy.
PEA-18	Incentivize the use of cool roofing products through the Town's Water Allocation Policy point system.	Extreme Heat	Low	Knightdale Planning	Internal	2017 – Establish appropriate level of incentive within policy	New strategy.
PEA-19	Update current approved plant list to add emphasis on drought tolerant species.	Drought	Moderate	Knightdale Planning	Internal	2016 – New plant list made available	New strategy.

Annex G
Town of Morrisville

This annex includes jurisdiction-specific information for the Town of Morrisville. It consists of the following five subsections:

- G.1 Town of Morrisville Community Profile
- G.2 Town of Morrisville Risk Assessment
- G.3 Town of Morrisville Vulnerability Assessment
- G.4 Town of Morrisville Capability Assessment
- G.5 Town of Morrisville Mitigation Strategy

G.1 TOWN OF MORRISVILLE COMMUNITY PROFILE

G.1.1 Geography and the Environment

Morrisville is town located in Wake County in the state of North Carolina. The land on which the current town sits was donated by Jeremiah Morris who gave it to the North Carolina Railroad to use in starting up the town.

Overall, Wake County is known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Summer temperatures generally venture into the 90s for highs and cool off to the 70s at night. Winter temperatures in can drop to below freezing but generally highs are in the 50s. Rainfall is most common in the summer months but occurs consistently throughout the year.

G.1.2 Population and Demographics

According to the 2010 Census, Morrisville has a population of 18,576 people. The jurisdiction has seen exceptional growth between 2000 and 2010, and the population density is almost 2,400 people per square mile. Population counts from the US Census Bureau for 1990, 2000, and 2010 are presented in **Table G.1**.

TABLE G.1: POPULATION COUNTS FOR MORRISVILLE

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
MORRISVILLE	1,022	5,208	18,576	256.68%

Source: US Census Bureau

The racial characteristics of the jurisdiction are presented in **Table G.2**. Whites make up the majority of the population in the jurisdiction, but other races also account for a large share.

TABLE G.2: DEMOGRAPHICS OF MORRISVILLE

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
MORRISVILLE	54.0%	12.9%	0.4%	32.7%	5.5%

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

G.1.3 Housing

According to the 2010 US Census, there are 8,357 housing units in Morrisville, the majority of which are single family homes or mobile homes. Housing information for the jurisdiction is presented in **Table G.3**.

TABLE G.3: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Seasonal Units, Percent (2010)	Median Home Value (2006-2010)
MORRISVILLE	3,210	8,357	8.6%	$266,600

Source: US Census Bureau

G.1.4 Infrastructure

Transportation

There are several major roadways that residents of Morrisville utilize. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs, one of which is I-540/NC-540 which is a partly completed loop that connects the jurisdiction to many of the other municipalities. In addition to the Interstate, there are many major highways that residents of the municipality utilize. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways in the include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities

Electrical power in the jurisdiction is provided by two entities and Duke Energy and Wake Electric Membership Corporation with Duke Energy providing service to a majority of the service. Water and sewer service is provided by two main entities as well: The City of Raleigh Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

Community Facilities

There are a number of buildings and community facilities located throughout Morrisville. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 2 fire stations, 1 police station, and 2 public schools located within the jurisdiction.

Citizens also have access to several parks, including three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the county, including the American Tobacco Trail which is a rails to trails project that is open to a wide variety of non-motorized uses.

G.1.5 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land as parks. There are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the jurisdiction consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

G.1.6 Employment and Industry

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

G.2 TOWN OF MORRISVILLE RISK ASSESSMENT

This subsection includes hazard profiles for each of the significant hazards identified in Section 4: *Hazard Identification* as they pertain to Morrisville. Each hazard profile includes a description of the hazard's location and extent, notable historical occurrences, and the probability of future occurrences. Additional information can be found in Section 5: *Hazard Profiles*.

G.2.1 Drought

Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, Morrisville has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that the county would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Historical Occurrences

According to the North Carolina Drought Monitor, Morrisville has had drought occurrences all of the last fourteen years (2000-2013). **Table G.4** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE G.4: HISTORICAL DROUGHT OCCURRENCES IN MORRISVILLE

Abnormally Dry **Moderate Drought** **Severe Drought** **Extreme Drought** **Exceptional Drought**

	Morrisville
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that Morrisville has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

G.2.2 Extreme Heat

Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to any geographic or political boundaries. All of Morrisville is susceptible to extreme heat conditions.

Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Morrisville. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the region. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the county. The most centralized location is in Raleigh at North Carolina State University. **Table G.5** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table G.5: Average Maximum Temperature in Raleigh, Wake County

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

G.2.3 Hailstorm

Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Morrisville is uniformly exposed to severe thunderstorms; therefore, all areas are equally exposed to hail which may be produced by such storms.

Historical Occurrences

According to the National Climatic Data Center, 7 recorded hailstorm events have affected Morrisville since 1993.[1] **Table G.6** is a summary of the hail events in Morrisville. **Table G.7** provides detailed information about each event that occurred. In all, hail occurrences resulted in over $0 (2013 dollars) in property damages. Hail ranged in diameter from 0.75 inches to 1.5 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value.

Table G.6: Summary of Hail Occurrences in Morrisville

Location	Number of Occurrences	Property Damage (2013)
Morrisville	7	$0

Source: National Climatic Data Center

[1] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Morrisville. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

TABLE G.7: HISTORICAL HAIL OCCURRENCES IN MORRISVILLE

	Date	Magnitude	Deaths/Injuries	Property Damage*
Morrisville				
Morrisville	7/10/1994	0.75 in.	0/0	$0
MORRISVILLE	7/14/2004	0.88 in.	0/0	$0
MORRISVILLE	5/9/2008	0.75 in.	0/0	$0
MORRISVILLE	5/20/2008	1.5 in.	0/0	$0
MORRISVILLE	5/20/2008	0.88 in.	0/0	$0
MORRISVILLE	6/14/2008	0.75 in.	0/0	$0
MORRISVILLE	5/5/2009	0.75 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that Morrisville has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the county.

G.2.4 Hurricane and Tropical Storm

Location and Spatial Extent

Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Morrisville. The entire jurisdiction is equally susceptible to hurricane and tropical storms.

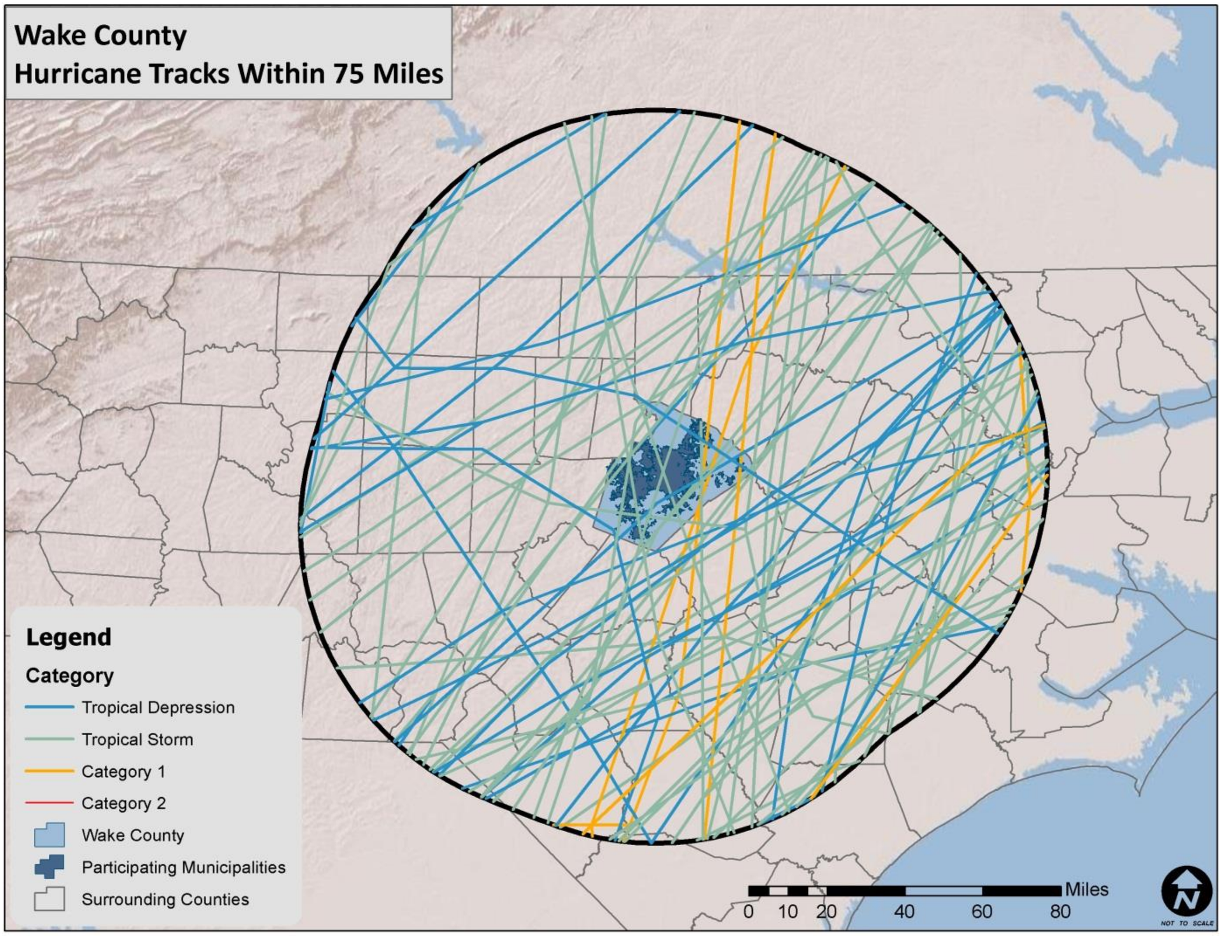
Historical Occurrences

According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[2] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms have traversed directly through Wake County as shown in **Figure G.1**. **Table G.8** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

[2] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

FIGURE G.1: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE G.8: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1
1882	NOT NAMED	53	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm
1959	CINDY	26	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression
2008	HANNA	40	Tropical Storm

Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Morrisville between 1950 and 2013. These storms are listed in **Table G.9** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE G.9: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made in 1996 (Hurricane Fran), 1999 (Hurricane Floyd), and 2003 (Hurricane Isabel) for the county.[3]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Tropical Storm Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

Probability of Future Occurrences
Given the inland location of the jurisdiction, it is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Morrisville. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the jurisdiction is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

[3] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

G.2.5 Lightning

Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Morrisville is uniformly exposed to lightning.

Historical Occurrences

According to the National Climatic Data Center, there has been one recorded lightning events in Morrisville since 1950, as listed in summary **Table G.10** and detailed in **Table G.11**.[4] However, it is certain that more lightning events have in fact impacted the jurisdiction. Many of the reported events are those that caused damage, and it should be expected that damages are likely much higher for this hazard than what is reported.

TABLE G.10: SUMMARY OF LIGHTNING OCCURRENCES IN MORRISVILLE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Morrisville	1	0/0	$5,305

Source: National Climatic Data Center

TABLE G.11: HISTORICAL LIGHTNING OCCURRENCES IN MORRISVILLE

	Date	Deaths/Injuries	Property Damage*	Details
Morrisville				
MORRISVILLE	7/6/2012	0/0	$5,305	An upper level disturbance moved across central North Carolina and interacted with moderate to strong instability to trigger scattered showers and thunderstorms. Several of these storms became severe and produced damaging winds and a few isolated severe hail reports.

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Although there were not a high number of historical lightning events reported in Morrisville via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S. National Lightning Detection Network (NLDN®), Morrisville is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Morrisville. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

be expected that future lightning events will continue to threaten life and cause minor property damages throughout the jurisdiction.

G.2.6 Severe Thunderstorm/High Wind

Location and Spatial Extent

A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Also, Morrisville typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Morrisville has uniform exposure to an event and the spatial extent of an impact could be large.

Historical Occurrences

Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011.[5] According to NCDC, there have been 5 reported thunderstorm/high wind events since 1994 for high wind and since 1950 for thunderstorms.[6] These events caused $0 (2013 dollars) in damages. **Table G.12** summarizes this information. **Table G.13** presents detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event.[7]

TABLE G. 12: SUMMARY OF THUNDERSTORM/HIGH WIND OCCURRENCES IN MORRISVILLE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Morrisville	5	0/0	$51,338

Source: National Climatic Data Center

TABLE G.13: HISTORICAL THUNDERSTORM/HIGH WIND OCCURRENCES IN MORRISVILLE

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Morrisville					
MORRISVILLE	5/6/1996	TSTM WIND	0 kts.	0/0	$0
MORRISVILLE	4/17/2000	TSTM WIND	50 kts.	0/0	$0
MORRISVILLE	6/7/2005	TSTM WIND	50 kts.	0/0	$0
MORRISVILLE	8/30/2008	THUNDERSTORM WIND	50 kts.	0/0	$0
MORRISVILLE	7/23/2012	THUNDERSTORM WIND	50 kts.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

[5] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional thunderstorm events have occurred in Morrisville. As additional local data becomes available, this hazard profile will be amended.
[7] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

Probability of Future Occurrences

Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire jurisdiction.

G.2.7 Tornado

Location and Spatial Extent

Tornadoes occur throughout the state of North Carolina, and thus in Morrisville. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Morrisville is uniformly exposed to this hazard.

Historical Occurrences

Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there have been no recorded tornado events in Morrisville since 1956 (**Table G.14**), resulting in nearly $0 (2013 dollars) in property damages.[8] Detailed information on these events can be found in **Table G.15**. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is likely that a high number of occurrences have gone unreported over the past 50 years.

TABLE G.14: SUMMARY OF TORNADO OCCURRENCES IN MORRISVILLE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Morrisville	0	0/0	$0

Source: National Climatic Data Center

TABLE G.15: HISTORICAL TORNADO IMPACTS IN MORRISVILLE

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Morrisville					
None reported					

*Property Damage is reported in 2013 dollars.
Source: NCDC

2011 Tornadoes- April 16, 2011

In 2011, the county and all of its jurisdictions were impacted by one of the worst tornado-related events in the county's recorded history. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries.

[8] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Morrisville. As additional local data becomes available, this hazard profile will be amended.

Probability of Future Occurrences

According to historical information, tornado events are not an annual occurrence for the jurisdiction. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Morrisville experience a direct tornado strike. The probability of future tornado occurrences affecting Morrisville is likely (10-100 percent annual probability).

G.2.8 Winter Storm and Freeze

Location and Spatial Extent

Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Morrisville is accustomed to smaller scale severe winter weather conditions and often receives severe winter weather during the winter months. Given the atmospheric nature of the hazard, the entire jurisdiction has uniform exposure to a winter storm.

Historical Occurrences

Severe winter weather has resulted in six disaster declarations in Morrisville. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. [9] According to the National Climatic Data Center, there have been no recorded winter storm events in Morrisville since 1993 (**Table G.16**).[10] These events resulted in $0 (2013 dollars) in damages. However, there have been 28 recorded countywide events and most severe winter weather events are only recorded at the county level.

TABLE G.16: SUMMARY OF WINTER STORM EVENTS IN MORRISVILLE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Morrisville	0	0/0	$0

Source: National Climatic Data Center

There have been several severe winter weather events in Morrisville. The text below describes one of the major events and associated impacts on the county. Similar impacted can be expected with severe winter weather.

1996 Winter Storm

This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and

[9] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[10] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional winter storm conditions have affected Morrisville.

power outages. Furthermore, citizens may resort to using inappropriate heating devices that could to fire or an accumulation of toxic fumes.

Probability of Future Occurrences

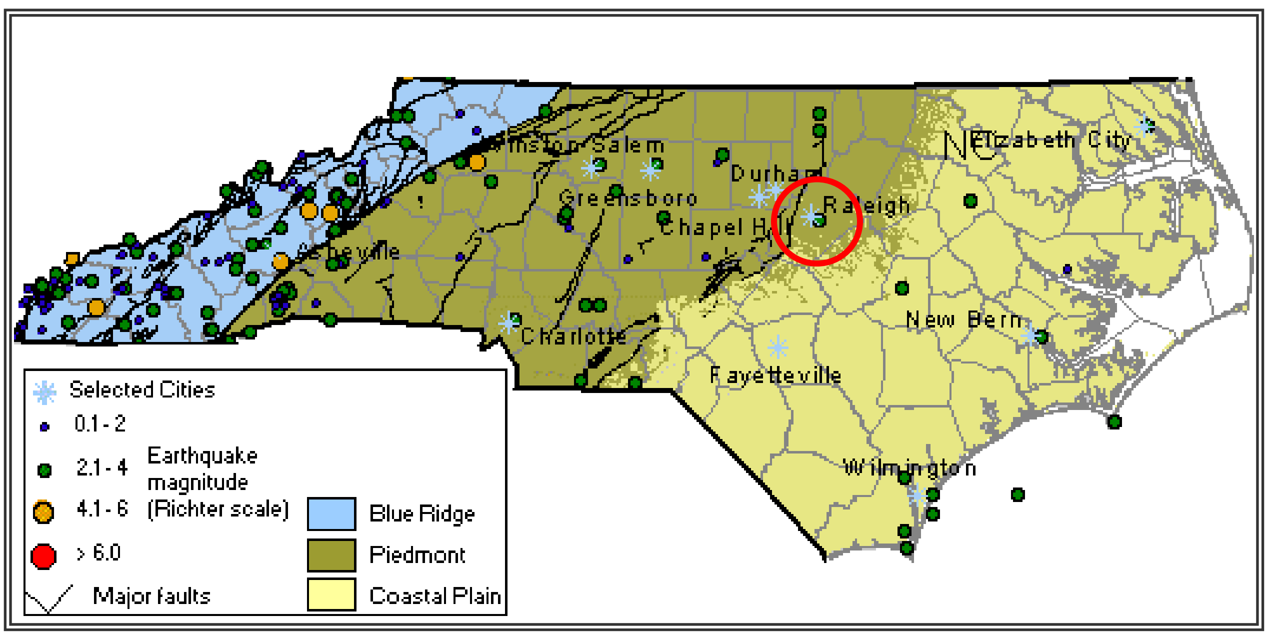
Winter storm events will remain a somewhat regular occurrence in Morrisville due to location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

G.2.9 Earthquake

Location and Spatial Extent

Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina. **Figure G.2** is a map showing geological and seismic information for North Carolina.

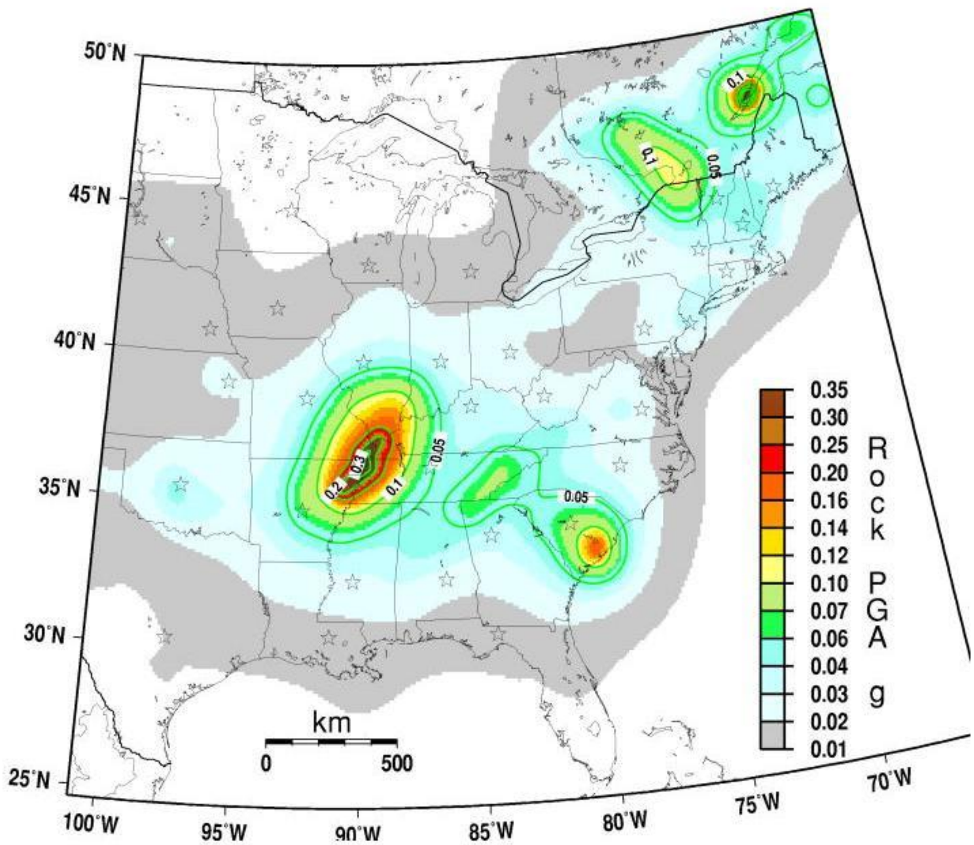
FIGURE G.2: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure G.3 shows the intensity level associated with Morrisville, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Morrisville lies within an approximate zone of level "2" to "3" ground acceleration. This indicates that the county exists within an area of moderate seismic risk.

FIGURE G.3: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

Historical Occurrences

Although no earthquakes are known to have occurred directly in Morrisville since 1874, several have occurred in the county and affected the municipality. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table G.17** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table G.18** presents a detailed occurrence of each event including the date, distance for the epicenter, and Modified Mercalli Intensity (if known). [11]

TABLE G.17: SUMMARY OF SEISMIC ACTIVITY IN MORRISVILLE

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Morrisville	--	--	--

Source: National Geophysical Data Center

[11] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

TABLE G.18: SIGNIFICANT SEISMIC EVENTS IN MORRISVILLE (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI (magnitude)
Morrisville				
None reported				

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Morrisville, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table G.19.**

TABLE G.19: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 - 1	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928*	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957*	Buncombe County, NC	3.7	VI	VI
11/24/1957*	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973*	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Morrisville occurrences.
** Conflicting reports on this event, intensity in North Carolina could have been either V or VI
Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Morrisville is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. The annual probability level for the county is estimated between 1 and 10 percent (possible).

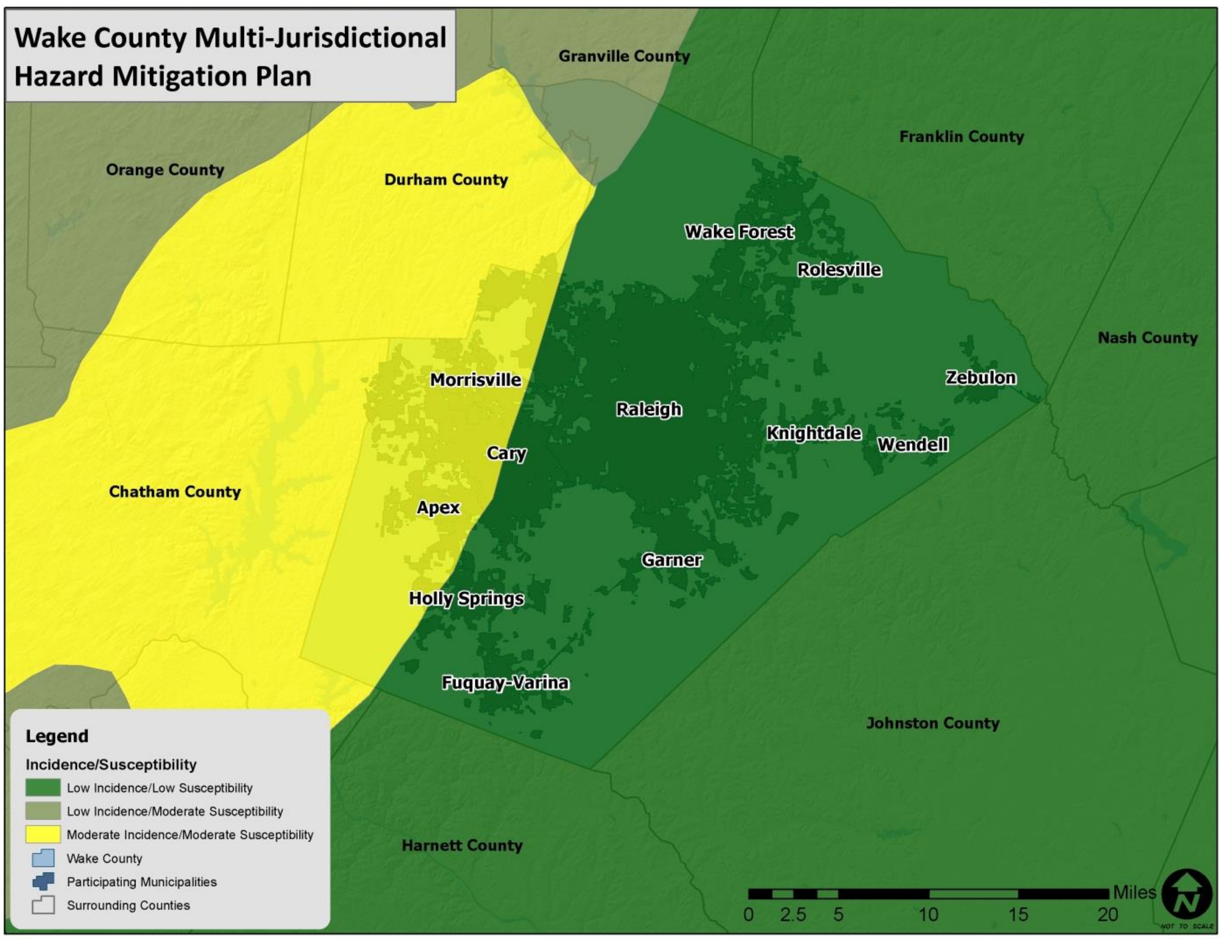
G.2.10 Landslide

Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Morrisville, although the overall risk is relatively low.

According to **Figure G.4** below, the majority of the county has low landslide activity. However there is a small area along the western border of the county (which includes parts of Morrisville) that has a moderate incidence and moderate susceptibility. In all other areas, there is low susceptibility.

FIGURE G.4: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

Historical Occurrences

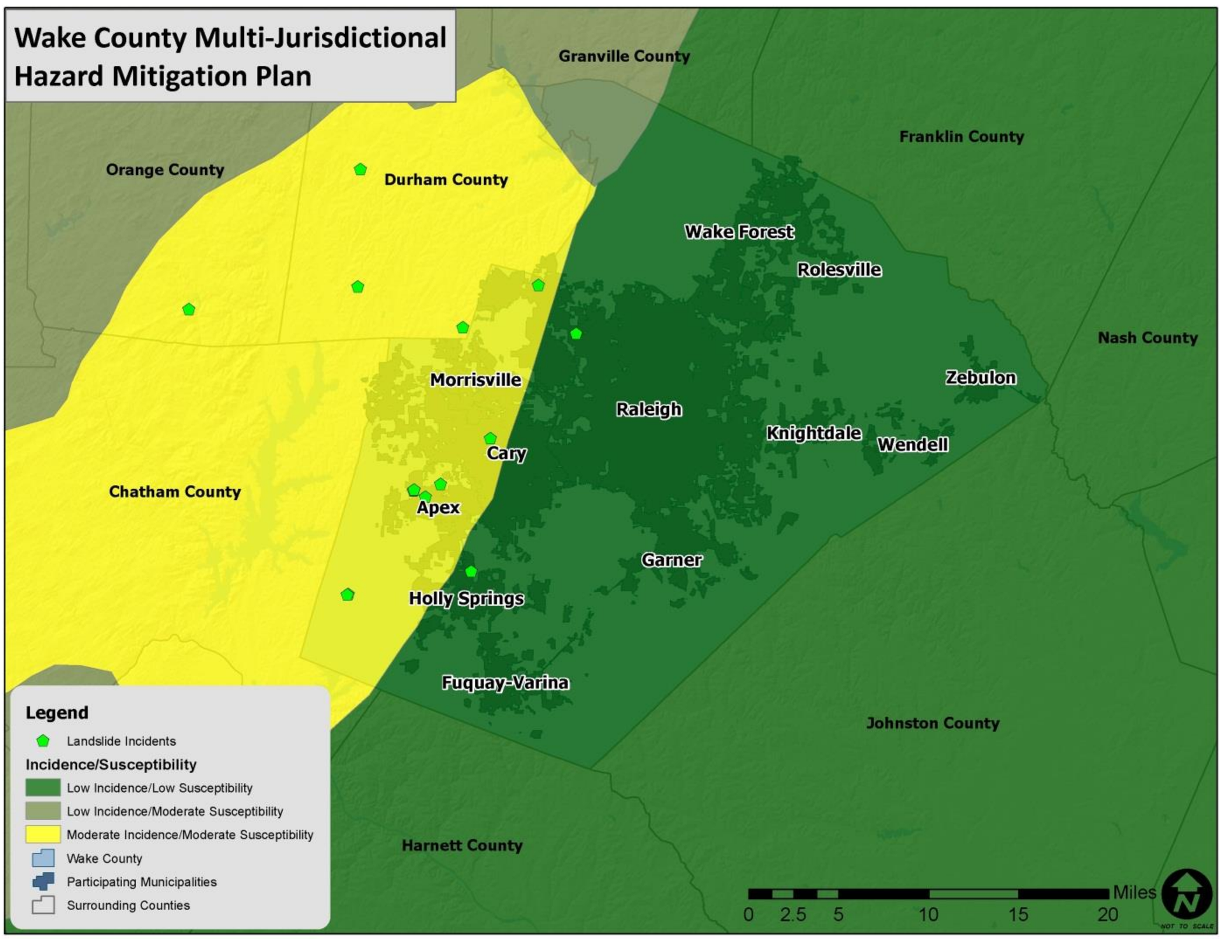
Steeper topography in some areas of Morrisville make the planning area susceptible to landslides. Most landslides are caused by heavy rainfall in the area. Building on steep slopes that was not previously possible also contributes to risk. **Table G.20** presents a summary of the landslide occurrence events as provided by the North Carolina Geological Survey[12]. The georeferenced locations of the landslide events presented in the aforementioned tables are presented in **Figure G.5**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred in Morrisville.

TABLE G.20: SUMMARY OF LANDSLIDE ACTIVITY IN MORRISVILLE

Location	Number of Occurrences
Morrisville	0

Source: North Carolina Geological Survey

FIGURE G.5: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for

[12] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Morrisville have greater risk than others given factors such as steepness on slope and modification of slopes.

G.2.11 Dam and Levee Failure

Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table G.21** explains these classifications.

TABLE G.21: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

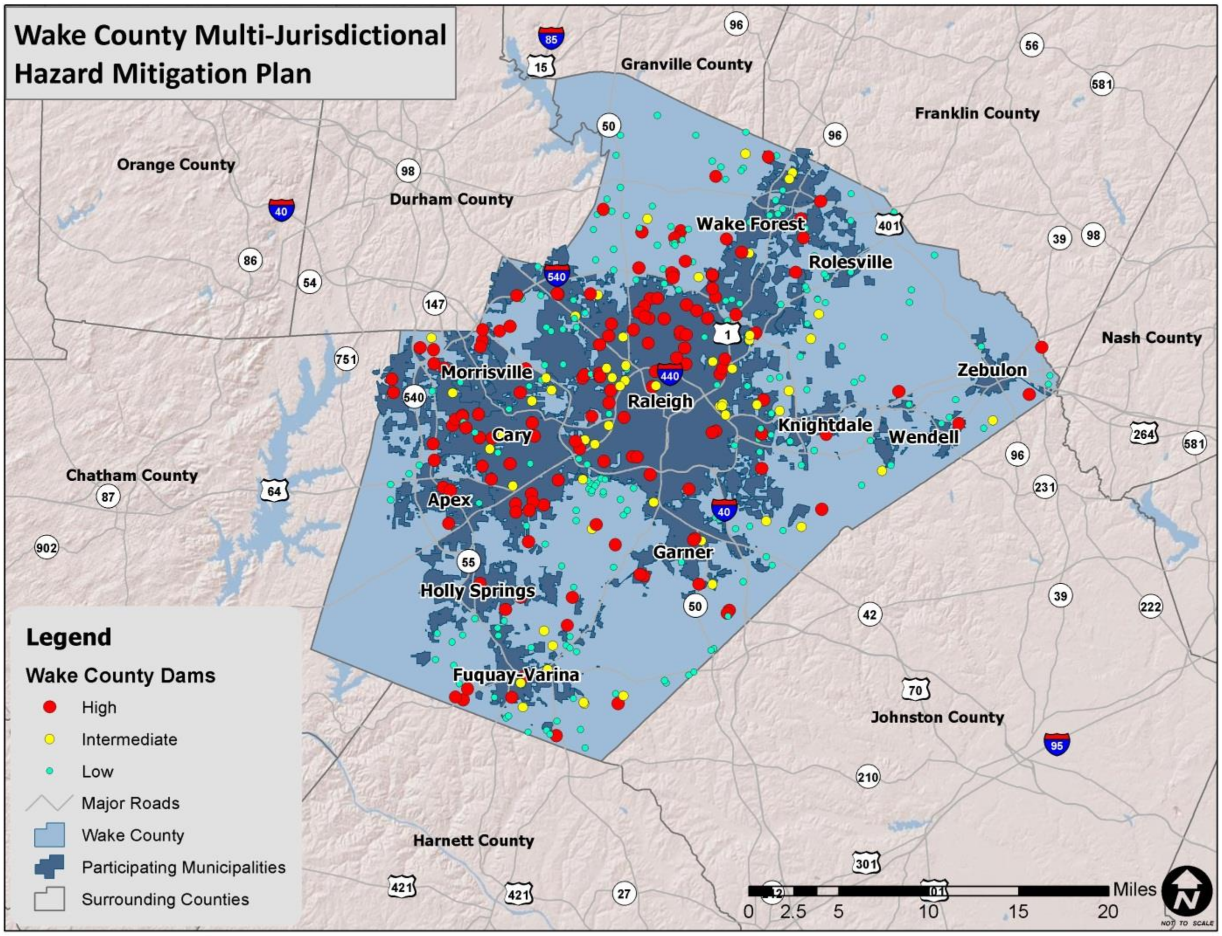
Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

According to the North Carolina Division of Land Management there are 4 dams in Morrisville.[13] **Figure G.6** shows the dam location and the corresponding hazard ranking for each. Of these dams, four are classified as high hazard potential. These high hazard dams are listed in **Table G.22**.

[13] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE G.6: WAKE COUNTY DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE G.22: MORRISVILLE HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Morrisville				
Crabtree Creek W/S #1 (PL-566)	High	64	480	Local Gov
Crabtree Creek W/S Dam #18	High	16	661	Local Gov
Perimeter Park West Dam	High	1	10	Private
Breckenridge Tract 9 & 10 Dam	High	3	83	Private

Source: North Carolina Division of Land Resources, 2012

It should also be noted that the North Carolina dam classification regulations were recently updated. As a result of the change, more dams are generally classified as high hazard.

Historical Occurrences

No dam breaches were reported in Morrisville. However, several breach scenarios in the jurisdiction could cause substantial damage.

Probability of Future Occurrences

Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

G.2.12 Erosion

Location and Spatial Extent

Erosion in Morrisville is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Morrisville soils have greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Morrisville, particularly along the banks of rivers and streams, but it is not an extreme threat. No areas of concern were reported by the planning committee.

Historical Occurrences

Several sources were vetted to identify areas of erosion in Morrisville. This includes searching local newspapers, interviewing local officials, and reviewing the previous hazard mitigation plan. Little information could be found and erosion was not addressed in the previous Morrisville hazard mitigation plan.

Probability of Future Occurrences

Erosion remains a natural, dynamic, and continuous process for Morrisville, and it will continue to occur. The annual probability level assigned for erosion is possible (between 1 and 10 percent annually).

G.2.13 Flood

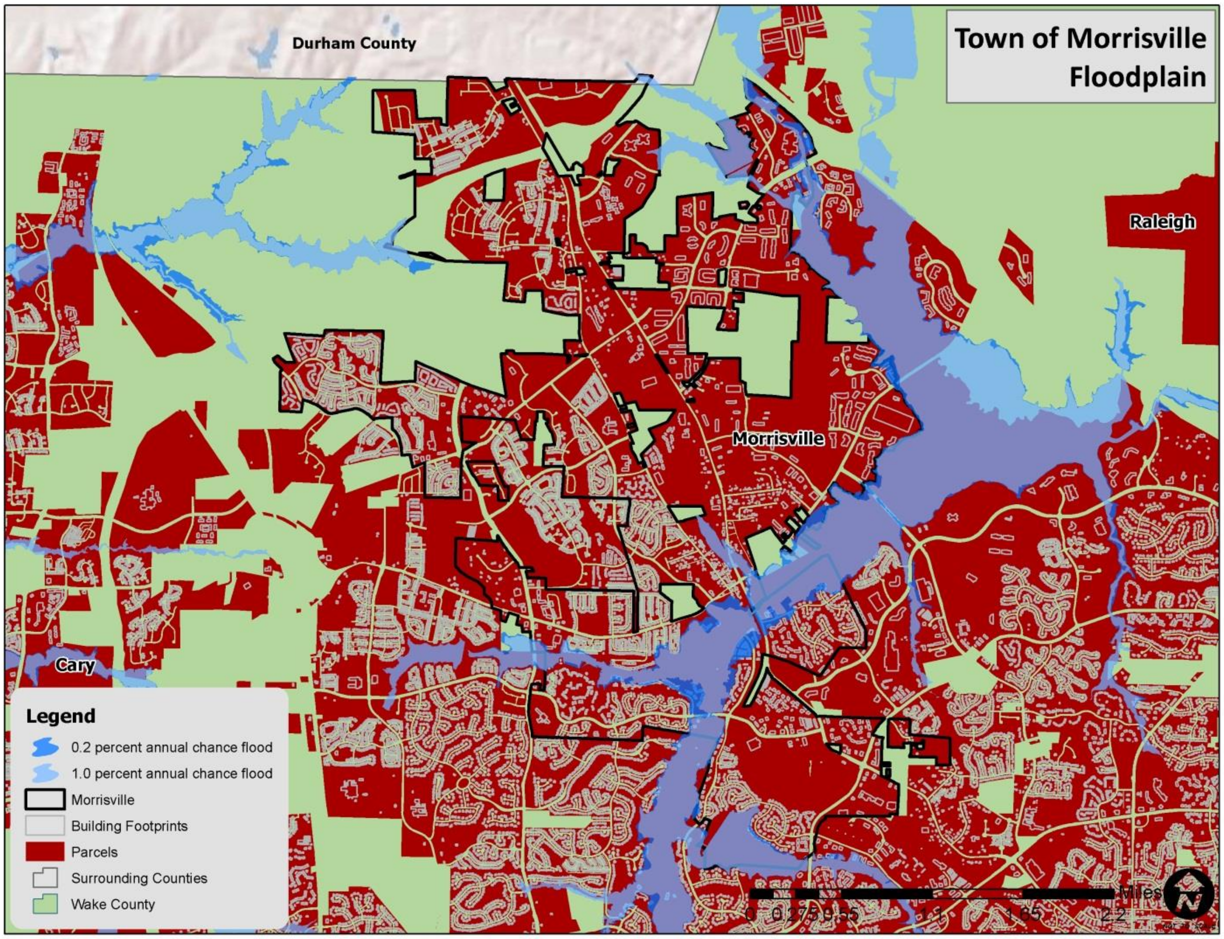
Location and Spatial Extent

There are areas in Morrisville that are susceptible to flood events. Special flood hazard areas in the jurisdiction were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[14] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 8 square miles that make up Morrisville, there are 0.60 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain).

These flood zone values account for 7.5 percent of the total land area in Morrisville. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas. **Figure G.7** illustrates the location and extent of currently mapped special flood hazard areas for Morrisville based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.

[14] The county-level DFIRM data used for Morrisville were updated in 2010.

FIGURE G.7: SPECIAL FLOOD HAZARD AREAS IN MORRISVILLE



Source: Federal Emergency Management Agency

Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported a total of 7 events in Morrisville since 1993.[15] A summary of these events is presented in **Table G.23**. These events accounted for $0 (2013 dollars) in property damage in the county.[16] Specific information on flood events, including date, type of flooding, and deaths and injuries, can be found in **Table G.24**.

TABLE G.23: SUMMARY OF FLOOD OCCURRENCES IN MORRISVILLE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Morrisville	7	0/0	$0

Source: National Climatic Data Center

[15] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.
[16] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

TABLE G.24: HISTORICAL FLOOD EVENTS IN MORRISVILLE

	Date	Type	Deaths/ Injuries	Property Damage*
Morrisville				
MORRISVILLE	7/29/2004	FLASH FLOOD	0/0	$0
MORRISVILLE	6/23/2006	FLASH FLOOD	0/0	$0
MORRISVILLE	6/23/2006	FLASH FLOOD	0/0	$0
MORRISVILLE	6/23/2006	FLASH FLOOD	0/0	$0
MORRISVILLE	8/30/2006	FLASH FLOOD	0/0	$0
MORRISVILLE	8/30/2008	FLASH FLOOD	0/0	$0
MORRISVILLE	5/5/2009	FLASH FLOOD	0/0	$0

Source: National Climatic Data Center

Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there have been 3 flood losses reported in Morrisville through the National Flood Insurance Program (NFIP) since 1978. A summary of these figures for the jurisdiction is provided in **Table G.25**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that additional instances of flood loss in Morrisville were either uninsured, denied claims payment, or not reported.

TABLE G.25: SUMMARY OF INSURED FLOOD LOSSES IN MORRISVILLE

Location	Flood Losses	Claims Payments
Morrisville	3	$66,219

Source: FEMA, NFIP

Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

As of July 2013, there are 0 non-mitigated repetitive loss properties located in Morrisville, which accounted for 0 losses and $0 in claims payments under the NFIP. Without mitigation, repetitive loss properties will likely continue to experience flood losses. **Table G.26** presents detailed information on repetitive loss properties and NFIP claims and policies for Morrisville.

TABLE G.26: SUMMARY OF REPETITIVE LOSS PROPERTIES IN MORRISVILLE

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Morrisville	0	-	0	$0	$0	$0	$0

Source: National Flood Insurance Program

Probability of Future Occurrences

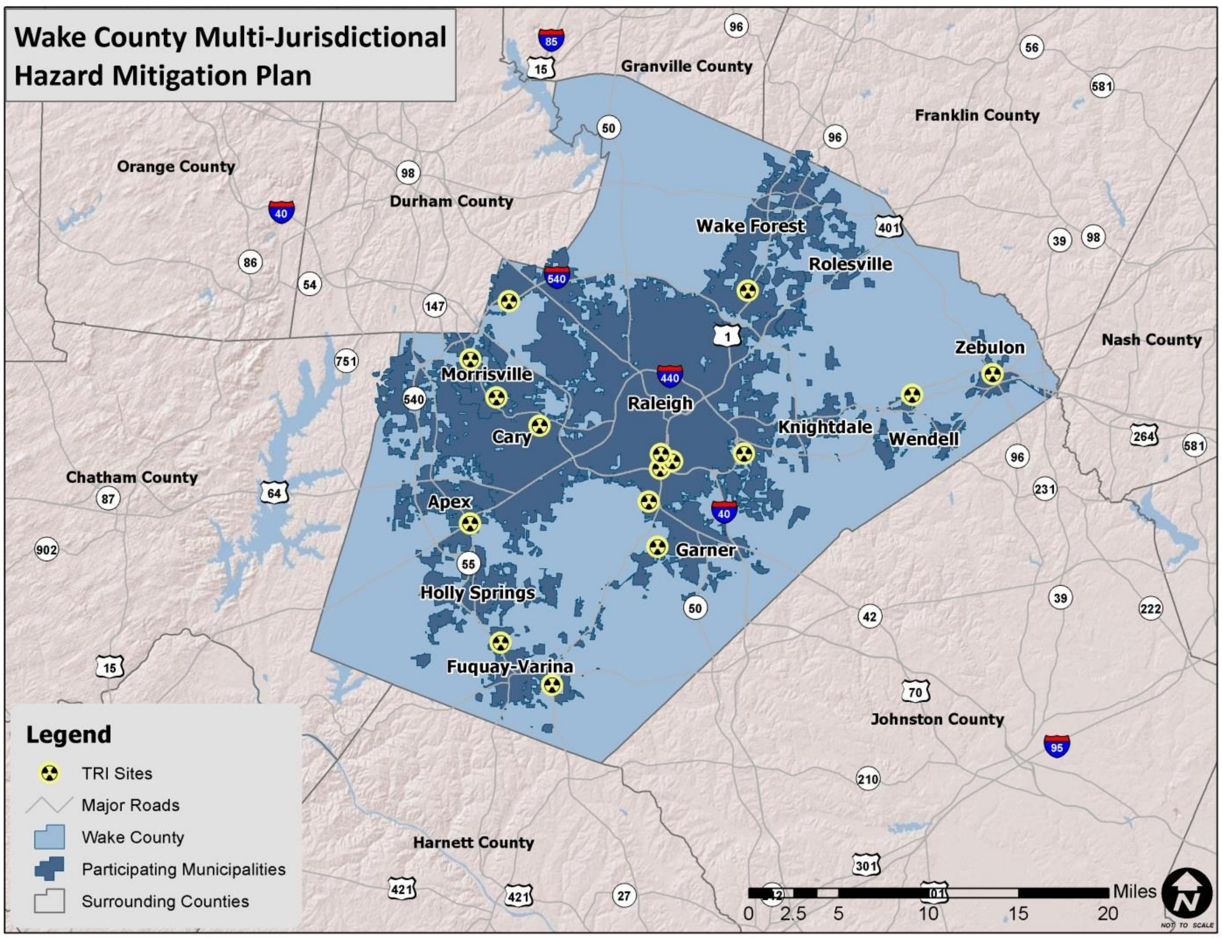
Flood events will remain a threat in areas prone to flooding in Morrisville, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability) The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above, which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

G.2.14 Hazardous Materials Incidents

Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Morrisville has one TRI site. This site is shown in **Figure G.8.**

FIGURE G.8: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the jurisdiction via roadways and rail. All roads that permit hazardous material transport are considered potentially at risk to an incident.

Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table G.27 presents detailed information on historic HAZMAT incidents reported in Morrisville.

TABLE G.27: SUMMARY OF HAZMAT INCIDENTS IN MORRISVILLE

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Morrisville							
I-1980080433	8/1/1980	MORRISVILLE	Air	No	0/0	$0	1 LGA
I-1992080023	6/25/1992	MORRISVILLE	Highway	No	0/0	$0	1 LGA
I-1993110976	10/8/1993	MORRISVILLE	Air	No	0/0	$0	0.1875 SLB
I-1994041339	3/18/1994	MORRISVILLE	Highway	No	0/0	$0	0.132086 LGA
I-1994060939	5/10/1994	MORRISVILLE	Highway	No	0/0	$0	10 SLB
I-1994070600	6/14/1994	MORRISVILLE	Highway	No	0/0	$0	0.08375 LGA
I-1994101619	9/29/1994	MORRISVILLE	Highway	No	0/0	$0	2.5 LGA
I-1994120661	11/17/1994	MORRISVILLE	Highway	No	0/0	$0	0.1875 SLB
I-1997080070	7/17/1997	MORRISVILLE	Highway	No	0/0	$0	1 LGA
I-1997080773	8/5/1997	MORRISVILLE	Highway	No	0/0	$0	1 LGA
I-1999030620	2/17/1999	MORRISVILLE	Highway	No	0/0	$0	1 LGA
I-2000070193	6/18/2000	MORRISVILLE	Highway	No	0/0	$0	2.63 LGA
I-2000070205	6/25/2000	MORRISVILLE	Highway	No	0/0	$0	0.004688 LGA
I-2001030835	3/12/2001	MORRISVILLE	Highway	No	0/0	$0	0.046875 LGA
I-2002050797	4/11/2002	MORRISVILLE	Highway	No	0/0	$0	0.007813 LGA
I-2003060466	5/21/2003	MORRISVILLE	Highway	No	0/0	$0	0.007813 LGA
I-2004040070	2/13/2004	MORRISVILLE	Highway	No	0/0	$0	2 LGA
I-2004050082	4/2/2004	MORRISVILLE	Highway	No	0/0	$0	1 LGA
I-2005020957	2/1/2005	MORRISVILLE	Air	No	0/0	$0	0.26418 LGA
I-2005100167	8/10/2005	MORRISVILLE	Highway	No	0/0	$0	3 LGA

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
I-2006060230	5/22/2006	MORRISVILLE	Highway	No	0/2	$0	0.5 LGA
I-2006080263	7/24/2006	MORRISVILLE	Highway	No	0/0	$0	0.007812 LGA
I-2006091247	8/22/2006	MORRISVILLE	Highway	No	0/0	$0	1.125 LGA
I-2007061257	6/6/2007	MORRISVILLE	Highway	No	0/0	$0	0.5 LGA
E-2009010088	1/8/2009	MORRISVILLE	Air	No	0/0	$0	0.26418 LGA
I-2009020410	2/19/2009	MORRISVILLE	Highway	No	0/0	$0	1 LGA
X-2009060140	5/28/2009	MORRISVILLE	Highway	No	0/0	$0	0.5 LGA
I-2011020202	1/21/2011	MORRISVILLE	Highway	No	0/0	$0	2 SLB
I-2004040070	2/13/2004	MORRISVILLE	Highway	No	0/0	$0	1 LGA
I-2006091247	8/22/2006	MORRISVILLE	Highway	No	0/0	$0	4 LGA
I-2001030835	3/12/2001	MORRISVILLE	Highway	No	0/0	$0	0.26418 LGA

Source: USDOT PHMSA

Probability of Future Occurrences

Given the location of one toxic release inventory site in Morrisville and several roadways and rails that transport hazardous materials, it is possible that a hazardous material incident may occur in the jurisdiction (between 1 percent and 10 percent annual probability). Local officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

G.2.15 Wildfire

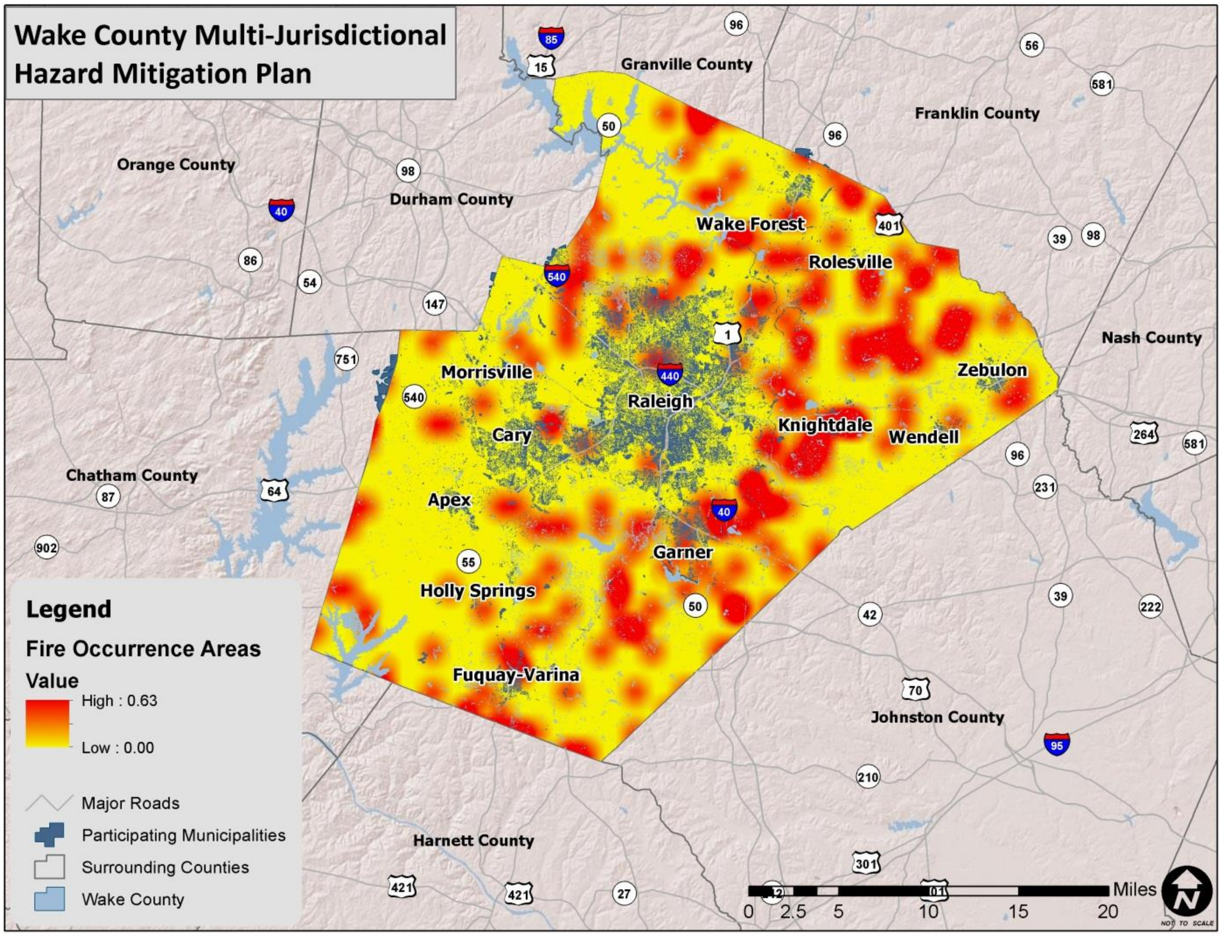
Location and Spatial Extent

The entire jurisdiction is at some risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas.

Historical Occurrences

Figure G.9 shows the Fire Occurrence Areas (FOA) in Morrisville based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. Therefore, even areas classified as at relatively high risk within the county are a relatively low risk compared to other areas of the state.

FIGURE G.9: HISTORIC WILDFIRE EVENTS IN MORRISVILLE



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of 16 wildfires annually which burn an average of 98 acres per year. The data indicates that most of these fires are small, averaging six acres per fire. **Table G.28** lists the number of reported wildfire occurrences in the county between the years 2003 and 2012.

TABLE G.28: HISTORICAL WILDFIRE OCCURRENCES IN MORRISVILLE

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Morrisville. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Morrisville for future wildfire events is possible (a 1 and 10 percent annual probability).

G.2.16 Nuclear Accident

Location and Spatial Extent

The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station.

Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 “Alerts” and 28 “Notice of Unusual Events” since 1986, which are shown in **Table G.29**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table G.29: SHEARON HARRIS EMERGENCY DECLARATION HISTORY

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on “B” Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).

Emergency Declaration	Date	Description
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of "A" Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - "B" diesel generator was being worked on; in accordance with test procedures, "A" diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported "Notice of Unusual Events" since 1986, which is shown in **Table G.30**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table G.30: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Probability of Future Occurrences

A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

G.2.17 Terror Threat

Location and Spatial Extent

A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table G.31** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

TABLE G.31 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food ▪ Banking and Finance ▪ Chemical ▪ Commercial Facilities ▪ Communications ▪ Critical Manufacturing ▪ Dams ▪ Defense Industrial Base ▪ Emergency Services ▪ Energy	▪ Government Facilities ▪ Healthcare and Public Health ▪ Information Technology ▪ National Monuments and Icons ▪ Nuclear Reactors, Materials, and Waste ▪ Postal and Shipping ▪ Transportation Systems ▪ Water

Historical Occurrences

Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

Probability of Future Occurrences

Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

G.2.18 Conclusions on Hazard Risk

The hazard profiles presented above were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and

experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

Hazard Extent

Table G.32 describes the extent of each natural hazard identified for Morrisville. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE G.32 EXTENT OF MORRISVILLE HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page G:4). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Morrisville has received this ranking three times over the fourteen year reporting period.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Morrisville was 1.5inches. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), Morrisville is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Thunderstorm Wind/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Morrisville was reported at 50 knots (approximately 58 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). Although there were no recorded tornado events in the jurisdiction, an F5 is possible.
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Morrisville. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is between low and moderate in Morrisville. There is also moderate susceptibility in some areas.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). Of the 4 dams in Morrisville, 4 are classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records located in Morrisville.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 7.5 percent of the total land area in Morrisville. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second.
Other Hazards	
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incidents reported in the jurisdiction are 4 LGA and 10 SLB, both released on the highway in Morrisville. It should be noted that larger events are possible.
Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).

Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

Priority Risk Index Results

In order to draw some meaningful planning conclusions on hazard risk for Morrisville, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). More information on the PRI and how it was calculated can be found in Section 5.20.2.

Table G.33 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups and Coordinating Committee. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE G.33: SUMMARY OF PRI RESULTS FOR MORRISVILLE

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	**2.5**
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	**2.4**
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	**2.5**
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	**2.1**
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	**3.1**
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.7**
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	**2.5**
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2**
Landslide	Possible	Minor	Small	Less than 6 hours	Less than 6 hours	**1.8**
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	**1.8**
Flood	Likely	Critical	Small	6 to 12 hours	Less than 1 week	**2.8**
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	**2**
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	**2.6**
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	**2.4**

G.2.16 Final Determinations on Hazard Risk

The conclusions drawn from the hazard profiling process for Morrisville, including the PRI results and input from the Regional Work Groups and Coordinating Committee, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table G.34**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Morrisville. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment* and below in Section G.3. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE G.34: CONCLUSIONS ON HAZARD RISK FOR MORRISVILLE

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Nuclear Accident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

G.3 TOWN OF MORRISVILLE VULNERABILITY ASSESSMENT

This subsection identifies and quantifies the vulnerability of Morrisville to the significant hazards previously identified. This includes identifying and characterizing an inventory of assets in the county and assessing the potential impact and expected amount of damages caused to these assets by each identified hazard event. More information on the methodology and data sources used to conduct this assessment can be found in Section 6: *Vulnerability Assessment*.

G.3.1 Asset Inventory

Table G.35 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for Morrisville (study area of vulnerability assessment).[17]

TABLE G.35: IMPROVED PROPERTY IN MORRISVILLE

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Morrisville	5,863	$2,618,506,417	4,377	$1,934,811,737

Table G.36 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in Morrisville. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. In addition, a list of secondary facilities was created to recognize the importance of these facilities in the event of a disaster. These facilities were not mapped, but it is important to recognize that they could be potentially impacted by nearly any of the identified hazards, especially those that are atmospheric or have no specific spatial delineation.

All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure G.10** shows the locations of the primary critical facilities in Wake County. **Table G.48**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility. As noted previously, this list is not all-inclusive and only includes information provided by the local government.

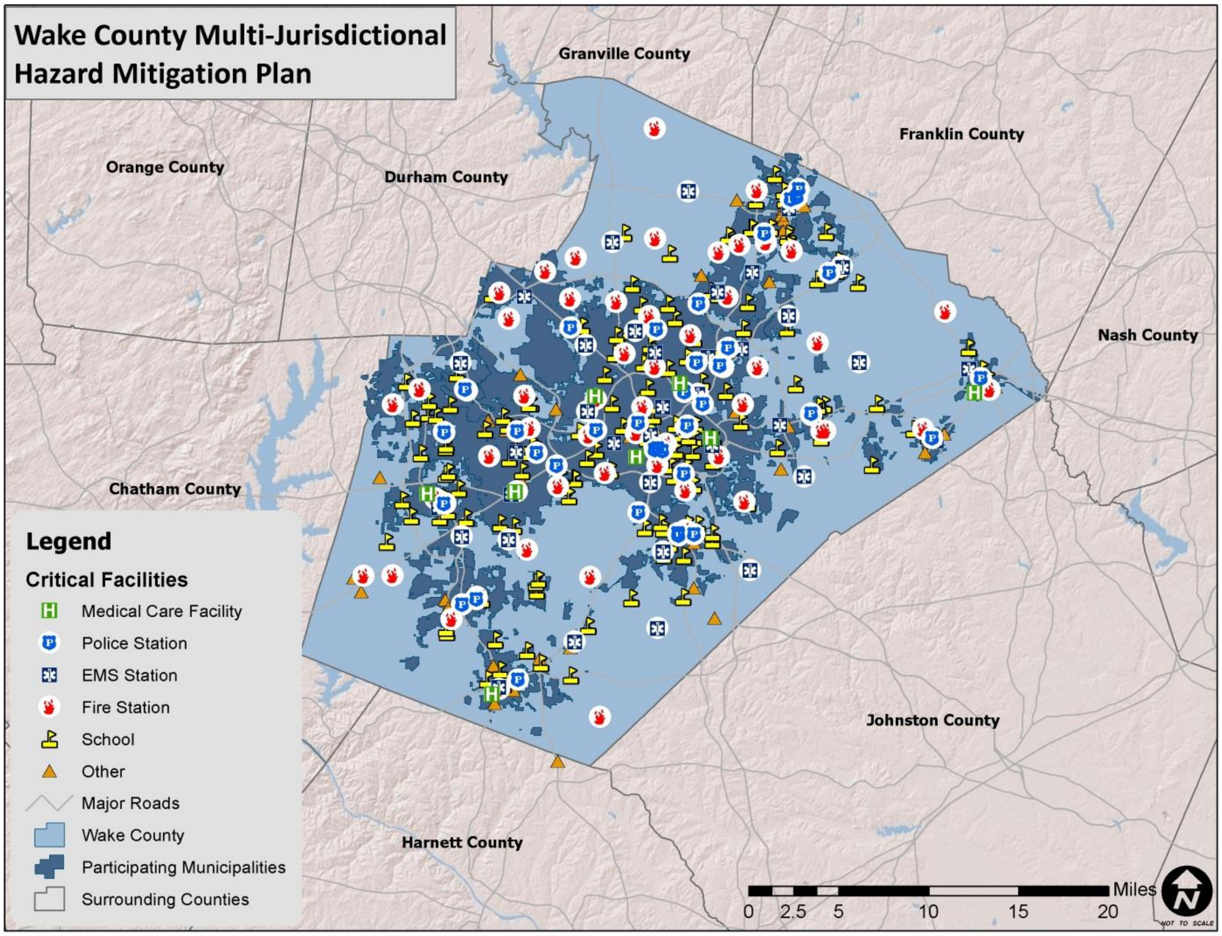
TABLE G.36: CRITICAL FACILITY INVENTORY IN MORRISVILLE

Location	Fire Stations	Police Stations	EMS Stations	Medical Care Facilities	Schools	Other
Morrisville	2	1	1	0	2	1

Source: Local Governments

[17] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

FIGURE G.10: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: Local Governments

G.3.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Morrisville that are potentially at risk to these hazards.

Table G.37 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, limited the results to county-wide estimates. The total population in Morrisville according to Census data is 18,576 persons. Additional population estimates are presented above in Section G.1.

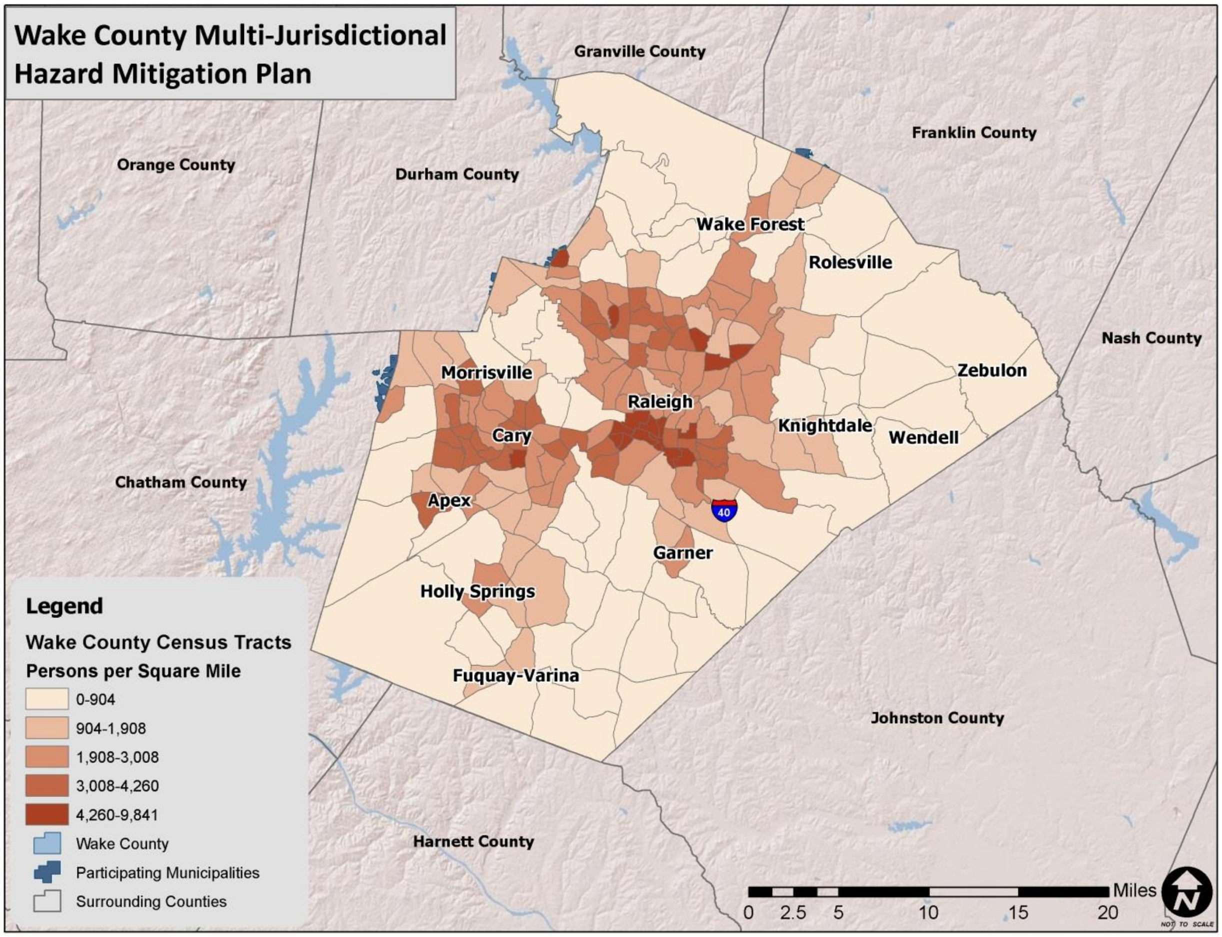
TABLE G.37: TOTAL POPULATION IN MORRISVILLE

Location	Total 2010 Population
Morrisville	18,576

Source: U.S. Census 2010

In addition, **Figure G.11** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[18]

FIGURE G.11: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

G.3.3 Vulnerability Assessment Results

As noted in Section 6: *Vulnerability Assessment*, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results, specific to Morrisville, are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total county exposure, and thus risk, was presented in **Table G.35**.

The annualized loss estimate for all hazards is presented at the end of this section in **Table G.47.**

The hazards presented in this section include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

[18] Population by census block was not available at the time this plan was completed.

Hurricane and Tropical Storm

Historical evidence indicates that Morrisville has a significant risk to the hurricane and tropical storm hazard. Several tracks have come near or traversed through the county, as shown and discussed in Section G.2.4.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes, and high winds and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table G.38.** Only losses to buildings are reported, in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE G.38: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table G.39.**

TABLE G.39: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Morrisville	72.4	81.4	100.0	106.5

Source: Hazus-MH 2.1

Social Vulnerability

Given equal susceptibility across the county, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Morrisville, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table G.48** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Morrisville. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

Earthquake
For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table G.40** summarizes the findings.

TABLE G.40: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability
It can be assumed that all existing future populations are at risk to the earthquake hazard.

Critical Facilities
The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table G.48**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Morrisville. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

Landslide
In order to complete the vulnerability assessment for landslides in Morrisville, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section G.2.10), tax parcel and building footprint data, and GIS analysis. **Table G.41** presents the potential at-risk property where available. All areas of Morrisville are identified as low or moderate incidence areas by the USGS landslide data. Some areas are also of moderate landslide susceptibility. Since there were no high incidence levels in the county, the moderate incidence level was used to identify different areas of concern for the analysis below.

TABLE G. 41: TOTAL POTENTIAL AT-RISK PARCELS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	**Moderate**		
Morrisville	5,863	4,377	$1,934,811,737

Source: USGS

Social Vulnerability

Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides. However, Morrisville is probably at somewhat higher risk than other jurisdictions.

Critical Facilities

All critical facilities are located in a moderate susceptibility area. This includes 1 EMS station, 2 fire stations, 1 police station, 2 schools, and 1 other. A list of specific critical facilities and their associated risk can be found in **Table G.48** at the end of this section.

In conclusion, a landslide has the potential to impact existing and future buildings, facilities, and populations in Morrisville, though some areas are at a higher risk than others due to a variety of factors. For example, steep slopes and modified slopes bear a greater risk than flat areas. Specific vulnerabilities for county assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

Flood

Historical evidence indicates that Morrisville is susceptible to flood events. A total of 7 flood events have been reported by the National Climatic Data Center resulting in $0 in damages. On an annualized level, these damages amounted to $0 for Morrisville.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for the county. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table G.42** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

TABLE G.42: ESTIMATED EXPOSURE OF PARCELS TO THE FLOOD HAZARD

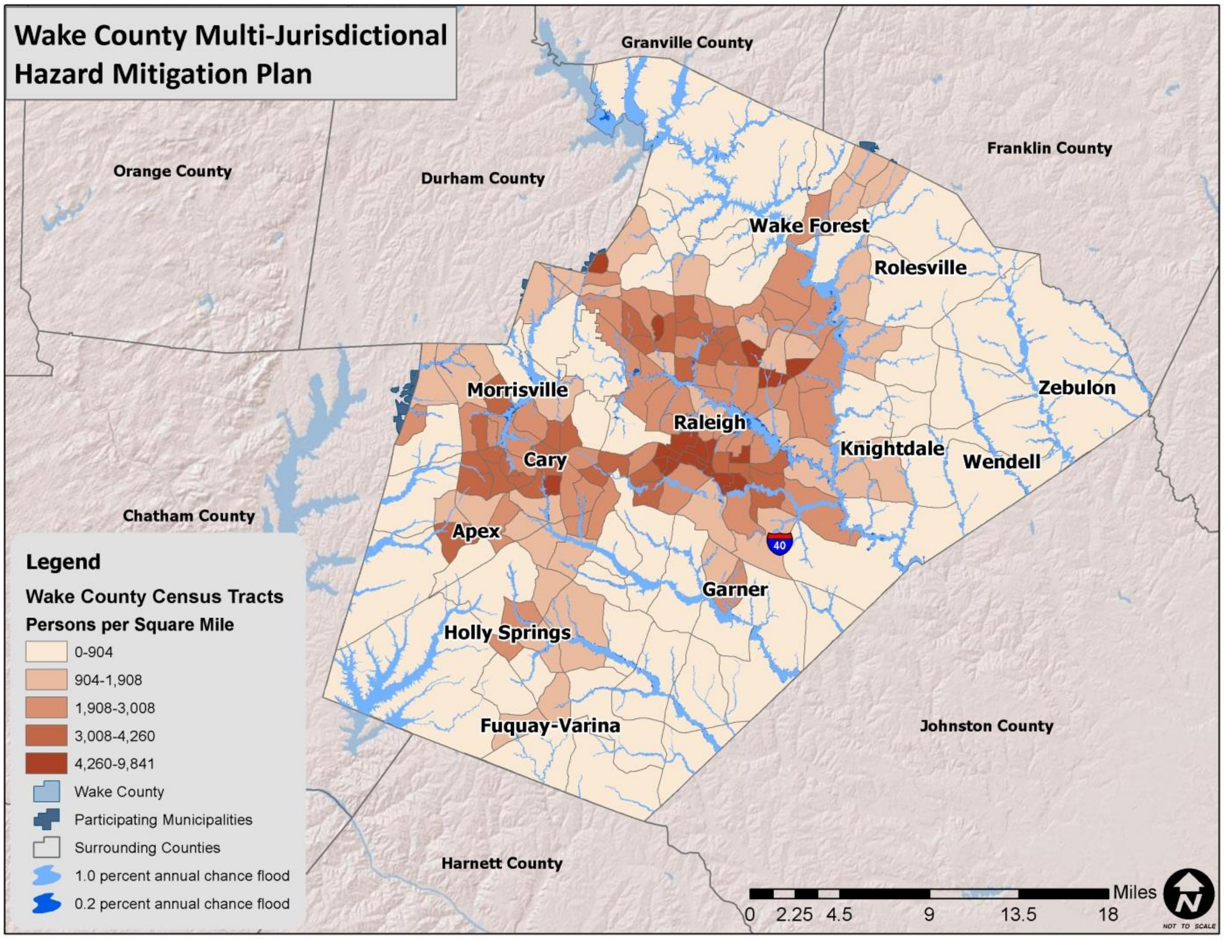
	1.0-percent ACF			0.2-percent ACF		
Location	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings
Morrisville	165	51	$179,283,154	67	97	$65,773,450

Source: FEMA DFIRM

Social Vulnerability

Since 2010 population was available at the tract level, it was difficult to determine a reliable figure on population at-risk to flood due to tract level population data. **Figure G.12** is presented to gain a better understanding of at risk population.

FIGURE G.12 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities

The critical facility analysis revealed that there are a no critical facilities located in the Morrisville 1.0-percent annual chance floodplain and 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. A list of specific critical facilities and their associated risk can be found in **Table G.48** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings and populations in Morrisville, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

Hazardous Materials Incident

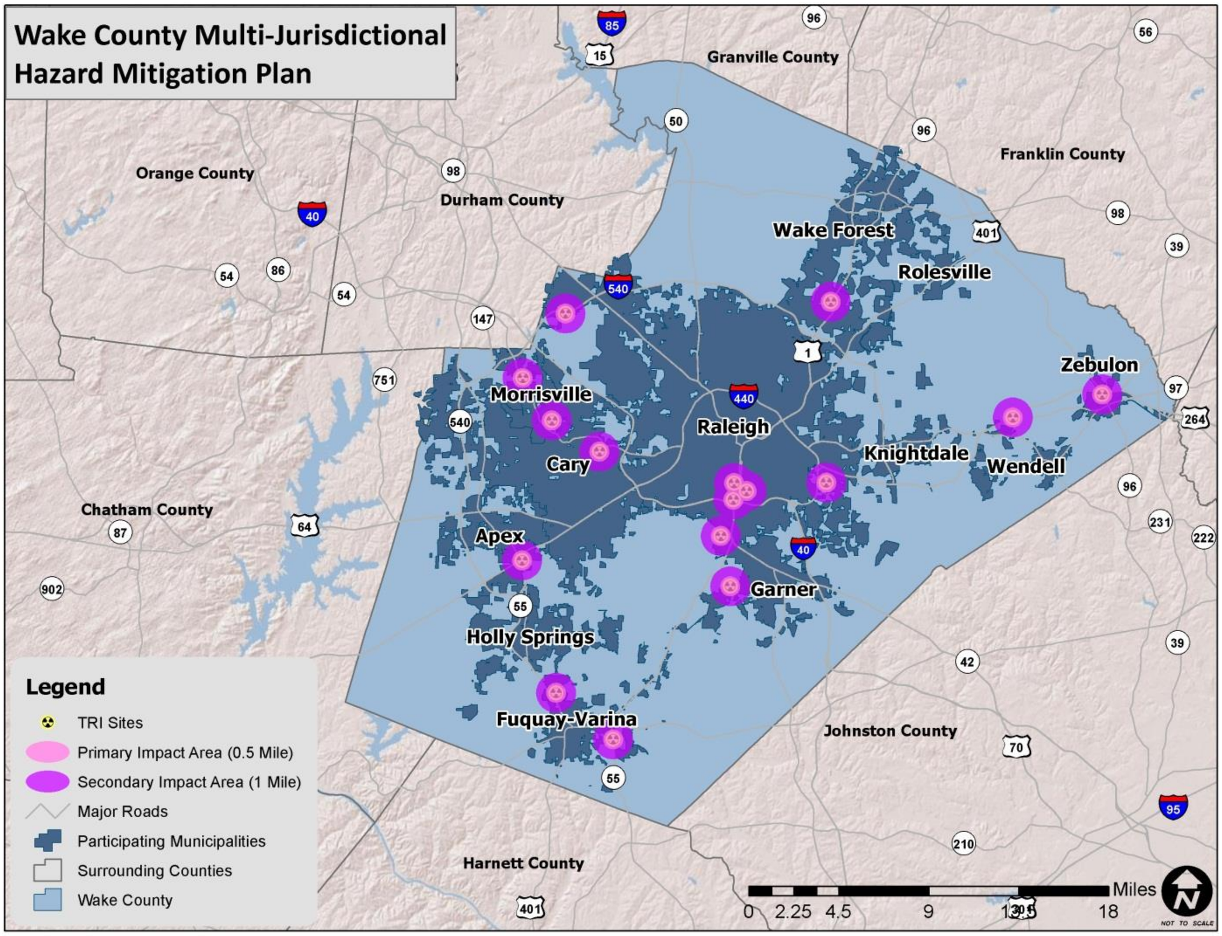
Although historical evidence and existing Toxic Release Inventory sites indicate that Morrisville is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Morrisville.

Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[19] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Morrisville, along with buffers, were used for analysis as shown in **Figure G.13.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the GIS buffer analysis. **Figure G.14** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table G.43** (fixed sites), **Table G.44** (mobile road sites) and **Table G.45** (mobile railroad sites).[20]

[19] This type of analysis will likely yield inflatedd results (generally higher than what is actually reported after an event).
[20] Note that parcels included in the 1.0-mile analysis are also included in the 0.5-mile analysis.

FIGURE G.13 : TRI SITES WITH BUFFERS IN MORRISVILLE



Source: EPA

TABLE G.43: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Morrisville	420	374	$229,928,761	1,596	1,243	$778,958,787

FIGURE G.14 : MOBILE HAZMAT BUFFERS IN MORRISVILLE

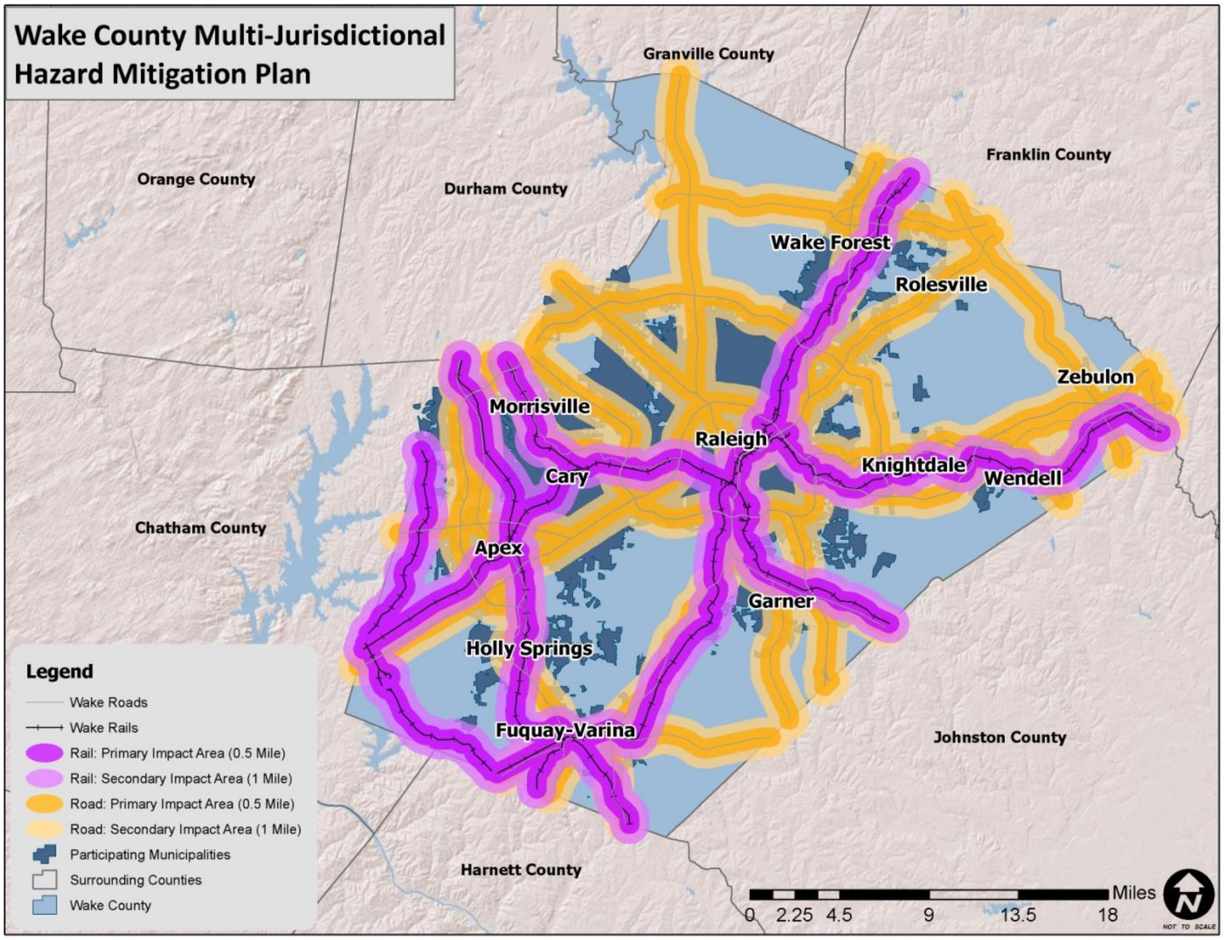


TABLE G.44: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Morrisville	3,316	2,335	$1,140,036,324	5,497	4,089	$1,794,514,730

TABLE G.45: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Morrisville	3,005	2,260	$1,041,309,811	5,376	3,981	$1,673,268,282

Social Vulnerability

Given high susceptibility across the jurisdiction, it is assumed that the total population is at risk to a hazardous materials incident. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities

Fixed Site Analysis:

The critical facility analysis for fixed TRI sites revealed that 3 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 2 facilities, an EMS station and a fire station. The remaining facility is in the secondary, 1.0-mile zone. A list of specific critical facilities and their associated risk can be found in **Table G.48** at the end of this section.

Mobile Analysis:

The critical facility analysis for road and railroad transportation corridors in Morrisville revealed that there are 6 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 6 facilities. The railroad buffer areas also include 6 facilities with 6 in the primary impact zone. It should be noted that many of the facilities located in the buffer areas for railroad are also located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table G.48** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Morrisville. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc. Further, incidents from neighboring jurisdictions could also have an impact.

Wildfire

Although historical evidence indicates that Morrisville is susceptible to wildfire events, there are few reports of damage. Upon conversion of the wildfire risk data (see Section 6: *Vulnerability Assessment*) and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the jurisdiction should be assumed to be very low. As such, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the county.

Social Vulnerability

All areas have relatively equal vulnerability and there is low susceptibility across the entire county.
It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in wildfire areas of concern. It should be noted, however, that several factors could impact the spread of a wildfire putting all facilities at risk. A list of specific critical facilities and their associated risk can be found in **Table G.48** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Morrisville.

Nuclear Accident

The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table G.46** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE G.46: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[21]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[22]
Morrisville	0	0	$0	5,863	4,377	$1,934,811,737

Social Vulnerability

Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in the 10-mile nuclear buffer area in Morrisville.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in Morrisville, though areas closer to the power plant are at a higher risk than others. All structures are at some risk given that they are all located within at least the 50-mile buffer area.

Conclusions on Hazard Vulnerability

Table G.47 presents a summary of annualized loss for each hazard in Morrisville. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, although an annualized loss was determined through the damage reported through historical occurrences at the municipal level, it is likely that the county-wide estimate (found in Section 6: *Vulnerability Assessment*) is potentially a better estimate. These values

[21] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.

[22] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

should be used as an additional planning tool or measure risk for determining hazard mitigation strategies.

TABLE G.47: ANNUALIZED LOSS FOR MORRISVILLE*

Event	Morrisville
Dam Failure	Negligible
Drought	Negligible
Erosion	Negligible
Extreme Heat	Negligible
Hail	Negligible
Hurricane & Tropical Storm	Negligible
Landslide	Negligible
Lightning	$5,305
Thunderstorm Wind/High Wind[23]	Negligible
Tornado	Negligible
Winter Storm & Freeze	Negligible
Flood	Negligible
Earthquake	Negligible
HAZMAT Incident	Negligible
Wildfire	Negligible
Nuclear Accident	Negligible
Terror Threat	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table G.48** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

[23] The annualized losses for these hazards were combined.

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TABLE G.48: AT-RISK CRITICAL FACILITIES IN MORRISVILLE

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
MORRISVILLE																								
MORRISVILLE	EMS STATION	X	X	X	X	X	X	X	X	X		X			X	X	X	X	X	X			X	X
MORRISVILLE #1	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
MORRISVILLE #2	FIRE STATION	X	X	X	X	X	X	X	X	X		X			X	X	X	X	X	X			X	X
TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
MORRISVILLE	POLICE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X			X	X
MORRISVILLE ES	SCHOOL	X	X	X	X	X	X	X	X	X		X											X	X
CEDAR FORK ES	SCHOOL	X	X	X	X	X	X	X	X	X		X				X	X	X	X	X			X	X

Secondary Critical Facilities are listed in slight contrast to Critical Facilities as their continued function has not been deemed as critical as primary facilities in the event of a disaster, but these facilities are extremely important. A loss of function to one of these facilities would have a definitively greater negative impact on the community's ability to respond to and recover from a disaster than a loss of function at other facilities/structures within the jurisdiction. In **Table G.49**, these facilities have been classified as either Significant Community Locations/Sheltering Centers or as Critical Resources Management Facilities. These facilities are all vulnerable to any of the atmospheric hazards and many are also likely vulnerable to other hazards identified above, though no locational analysis was carried out to this end.

TABLE G.49: MORRISVILLE SECONDARY CRITICAL FACILITIES

Facility Name	Address*	Type
Morrisville		
Sterling Montessori School	2020 Treybrooke Drive	Significant Community Location or Sheltering Center
Parks and Recreation Administration Building	240 Town Hall Drive	Significant Community Location or Sheltering Center
Public Works	414 Aviation Parkway	Critical Resources Management (Energy, Water, etc.)
Cedar Fork Community Center	1050 B Town Hall Drive	Significant Community Location or Sheltering Center

**Some address information could not be provided or was not applicable to the facility*

G.4 TOWN OF MORRISVILLE CAPABILITY ASSESSMENT

This subsection discusses the capability of the Town of Morrisville to implement hazard mitigation activities. More information on the purpose and methodology used to conduct the assessment can be found in Section 7: *Capability Assessment*.

G.4.1 Planning and Regulatory Capability

Table G.50 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the Town of Morrisville. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE G.50: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning Tool/Regulatory Tool	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan (Parks & Rec/Greenway Plan	Stormwater Management Plan/Ordinance	Natural Resource Protection Plan	Flood Response Plan	Emergency Operations Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	National Flood Insurance Program (NFIP)	NFIP Community Rating System
Morrisville	✓	✓		✓	✓			✓	✓			✓			✓	✓	✓	*		✓	✓	✓	

A more detailed discussion on the town's planning and regulatory capabilities follows.

Emergency Management

Hazard Mitigation Plan
The Town of Morrisville has previously adopted a hazard mitigation plan.

Emergency Operations Plan
The Town of Morrisville has adopted the Wake County Emergency Operations Plan. The town also maintains a municipal-level emergency operations plan.

Continuity of Operations Plan
The Town of Morrisville has adopted a municipal-level continuity of operations plan.

General Planning

Comprehensive Land Use Plan
The Town of Morrisville has adopted a land use plan.

Capital Improvements Plan
The Town of Morrisville has a five-year capital improvement plan in place.

Zoning Ordinance
The Town of Morrisville adopted a local unified development ordinance in December 2013 and it takes effect July 1, 2014.

Subdivision Ordinance
The Town of Morrisville adopted a local unified development ordinance in December 2013 and it takes effect July 1, 2014.

Building Codes, Permitting, and Inspections
North Carolina has a state compulsory building code which applies throughout the state. The building code is enforced within the town's planning jurisdiction by the Town of Morrisville Inspections Department.

Floodplain Management

Table G.51 provides NFIP policy and claim information for the Town of Morrisville.

TABLE G.51: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
Morrisville	11/01/78	04/16/07	92	$24,778,300	3	$66,219

Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Flood Damage Prevention Ordinance
All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. The Town of Morrisville participates in the NFIP and has adopted flood damage prevention regulations.

Open Space Management Plan
The Town of Morrisville has adopted a parks and recreation master plan.

Stormwater Management Plan
The Town of Morrisville has not adopted a stormwater management plan; however, the town has adopted a stormwater management ordinance.

G.4.2 Administrative and Technical Capability

Table G.52 provides a summary of the capability assessment results for the Town of Morrisville with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in the town with the specified knowledge or skill.

TABLE G.52: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	Planners with knowledge of land development/land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency Manager	Floodplain Manager	Land Surveyors	Scientists familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Resource development staff or grant writers
Morrisville	✓	✓	✓	✓	✓		✓	✓	✓	

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

G.4.3 Fiscal Capability

Table G.53 provides a summary of the results for the Town of Morrisville with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plan.

TABLE G.53: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes (or taxing districts)	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.
Morrisville	✓		✓						✓	✓

G.4.4 Political Capability

The previous hazard mitigation plan indicates that, with exception of those efforts that may have perceived negative impact on property values, opposition to previous mitigation measures is not evident in the Town of Morrisville. The political structure (elected officials and staff) is well organized and responsive to community needs. The governing board is educated and remains up-to-date on the hazards that threaten Morrisville and appears willing to promote the measure in the hazard mitigation plan. While staff has taken great effort to involve citizens, there has not been an overwhelming public response. This lack of response may be due to the fact the community has never been heavily impacted by a natural disaster. This is why public education and awareness campaigns about the economic efficiency and social utility of mitigation measures outlined in the policies may help foster citizen responsiveness In the future.

G.4.5 Conclusions on Local Capability

Table G.54 shows the results of the capability assessment using the designed scoring methodology described in Section 7: *Capability Assessment*. The capability score is based solely on the information found in existing hazard mitigation plan and readily available on the town's government website. According to the assessment, the local capability score for the town is 41, which falls into the high capability ranking.

TABLE G.54: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
Morrisville	41	High

G.5 TOWN OF MORRISVILLE MITIGATION STRATEGY

This subsection provides the blueprint for Morrisville to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Regional Work Groups and the findings and conclusions of the capability assessment and risk assessment. Additional Information can be found in Section 8: *Mitigation Strategy* and Section 9: *Mitigation Action Plan*.

G.5.1 Mitigation Goals

Morrisville developed seven mitigation goals in coordination with Wake County and the other participating municipalities. The county-wide mitigation goals are presented in **Table G.55**.

TABLE G.55: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

G.5.2 Mitigation Action Plan

The mitigation actions proposed by Morrisville are listed in the following Mitigation Action Plan.

Town of Morrisville Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Improve road visibility and safety by evaluating existing road conditions and paving and/or placing new reflector tape or paint along road edges and in the divided line on all major Town roads.	Flooding, Hurricane, Tornado/ Thunderstorm	Low	Morrisville Director of Public Works	Morrisville Director of Public Works	2016	The town hires an outside firm to perform a Pavement Condition Report on all Town roads every two years. Deficiencies are recorded, and a prioritized schedule on needed repairs is documented.
P-2	Evaluate and update the Town of Morrisville Multi-Hazard Emergency Response Plan on an annual basis.	All	Low	Morrisville Director of Community Services	Morrisville Director of Community Services	2015, Annually	No updates were required in 2013. The town will continue to annually update and review this plan in the future.
P-3	Monitor trees and branches in public areas at risk of breaking or falling in wind, ice, and snow storms. Prune or thin trees or branches when they would pose an immediate threat to property or other significant structures or critical facilities in the Town.	Hurricanes, Tornado/ Thunderstorm, Severe Winter Weather	Moderate	Morrisville Director of Public Works	Morrisville Director of Public Works	Completed	The Town's Public Works Department regularly inspects Town parks, grounds and right of ways for hazardous trees and/or limbs. If trees or limbs have the potential of causing harm or property damage they are removed. Public Works performs approximately four inspections annually. This action will be removed from the next update.
P-4	Maintain all tax parcel information, floodplain locations and frequent flooding areas in Geographic Information Systems (GIS).	Hurricanes, Tornado/Thunderstorms, Flood	Low	Morrisville Senior Planner/Mapping Specialist, Civil Engineer	Morrisville Senior Planner/Mapping Specialist, Civil Engineer	2015, annual review and update	Tax parcel information and floodplain maps have been maintained, and no new flood areas have been identified. Current funding for this policy is adequate. This information will need to be updated on an annual basis.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-5	Evaluate and update the current floodplain ordinances and policies.	Flood	High	Morrisville Planning Director, Town Engineer	Morrisville Planning Director, Town Engineer	Completed	The Town's floodplain management ordinance was integrated in the Unified Development Ordinance (UDO), which was adopted December 10, 2013 with an effective date of July 1, 2014.
P-6	Develop a Debris Management Plan, in conjunction with Wake County's Debris Management Plan, to address debris associated with natural hazards.	All	Moderate	Morrisville Director of Community Services, Director of Public Works	Morrisville Director of Community Services, Director of Public Works	Completed	A Debris Management Plan was developed in 2010. This policy is complete.
P-7	Explore amending the Zoning and/or Subdivisions Ordinances to require all utilities to be placed underground for all new projects and major amendments to existing projects.	Hurricanes, Tornado/ Thunderstorm, Severe Winter Weather	Moderate	Morrisville Planning Director	Morrisville Planning Director	Completed	The Unified Development Ordinance (UDO), which was adopted December 10, 2013 with an effective date of July 1, 2014, requires all new developments to install electric distribution feeder lines and all other utility lines located on the development site and/or along the public right-of-way abutting the site to be installed underground (Section 5.11.B.2, Underground Installation of Required in the UDO). This policy has been met.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Property Protection							
PP-1	Evaluate the need and the cost of purchasing records protection services for information technology related services.	Flooding, Hurricanes, Tornado/ Thunderstorm, Wild-fire	Low	Morrisville Director of Information Technology	General Fund	Completed	A full tape backup of all data from all servers is captured every Sunday night. Each subsequent night, any data that has changed is also backed up to tape. Tapes are stored in a fire proof safe in the Town Hall server room, and additional sets are secured off-site with Iron Mountain. This action will be removed from the next update.
PP-2	Seek Federal, State, and County funding opportunities to purchase property located completely or partially in FEMA designated floodplains in order to mitigate potential property damage and protect natural resources.	Hurricanes, Flooding, Tornado/ Thunderstorm	Low	Morrisville Director of Community Services, Director of Development Services	Federal, State and County Funds	2018	The Town has not sought Federal, State, or Wake County funding to purchase property or land that is completely or partially located in FEMA designated floodplain. The town will look to implement this action in the future where funding allows.
Natural Resource Protection							
NRP-1	Explore the possibility of promoting or requiring xeriscaping as a water conservation measure.	Drought/Heat Wave	Low	Morrisville Planning Director	General Fund	Completed	The Unified Development Ordinance (UDO), which was adopted December 10, 2013 with an effective date of July 1, 2014, encourages the use of drought-tolerant vegetation native to the Morrisville. This policy has been met.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-2	Evaluate expanding the riparian buffer from 50 to 100 feet.	Hurricanes, Flooding, Tornado/Thunderstorm	Low	Morrisville Planning Director	General Fund	Completed	The Unified Development Ordinance (UDO), which was adopted December 10, 2013 with an effective date of July 1, 2014, allows development to occur in a manner that meets the intent of this Ordinance, yet through an alternative design that does not strictly adhere to the Ordinance's design standards.
Structural Projects							
SP-1							
Emergency Services							
ES-1	Monitor the status of backup generators, communications and vehicles for all Morrisville owned critical public facilities. Test generators, communications equipment and vehicles on a regular basis, not only for maintenance, but to confirm that the equipment continues to match the needs of critical facility expansion or updated operations. Purchase and repair equipment as necessary.	All	Low	Morrisville Director of Public Works, Fire Chief, Police Chief	Part of normal town duties, General Fund	Completed	To ensure critical public facilities are able to respond during a disaster, the Town tested generators a minimum of once a month and provided bi-annual maintenance and load tests. Town emergency communication equipment and vehicles are used and maintained year round. The Director of Information Technology should likely be removed as a responsible party during the next 5-year update process.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Public Education and Awareness							
PEA-1	Disperse via the Morrisville Connection newsletter a posting which provides information regarding natural hazard emergency response and preparedness actions the public can take.	Drought/Heat Wave, Flood, Hurricane, Severe Winter Weather	Low	Morrisville Public Information Officer	Part of normal town duties, General Fund	2019	ReadyWake! Emergency Notification System - We informed our residents that we switched to ReadyWake as our emergency notification system. The article encourages residents to sign up to receive emergency notifications. The town will continue to develop new ways to reach out to the public in the future.
PEA-2	Notify citizens of the public hearing on the Hazard Mitigation Plan annual progress report.	All	Low	Morrisville Planning Director	Part of normal town duties, General Fund	2015, Annually	Staff placed an ad in the News and Observer to notify residents of the public hearing. While the current funding is adequate for this policy, staff recommends changing the notification from a legal ad in the newspaper for annual updates to the Town website, Twitter, Facebook, the Morrisville Connection, and/or other media resources that reach a larger audience.
PEA-3	Continue providing website link to Federal and State Declared Emergencies affecting the Town.	All	Low	Morrisville Public Information Officer	Part of normal town duties, General Fund	During a disaster event	Through 2014, when Federal or State Declared Emergencies are made, the website is updated.
PEA-4	Continue advertising the Town of Cary's Water Conservation and Restriction Plans on the Town website.	Drought/Heat Wave	Low	Morrisville Public Information Officer	Part of normal town duties, General Fund	Completed	The Morrisville Connection, which is available on the Town website, provides information from the Town of Cary.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-5	Continued participation in CodeRED, an automated citizen alert system that notifies the public of pending emergencies and actions necessary to take in response to a particular emergency.	All	Moderate	Morrisville Director of Community Services, Fire Chief	General Fund	Completed	The Town transitioned from CodeRED to ReadyWake! in December 2012. ReadyWake! is offered by Wake County and provides the same function as CodeRED.
PEA-6	Utilize volunteer citizen committees, such as CERT or Public Safety Commit-tee, to educate residents in preparing for natural hazards.	All	Low	Morrisville Fire Chief and Police Chief	General Fund	2016	CERT members received monthly training in 2013. The training topics included general emergency/disaster preparedness and response, along with fire safety. Morrisville had 35 active CERT members is 2013. The town will look to enhance the participation of citizens on CERT in the years to come.

Annex H
City of Raleigh

This annex includes jurisdiction-specific information for the City of Raleigh. It consists of the following five subsections:

- H.1 City of Raleigh Community Profile
- H.2 City of Raleigh Risk Assessment
- H.3 City of Raleigh Vulnerability Assessment
- H.4 City of Raleigh Capability Assessment
- H.5 City of Raleigh Mitigation Strategy

H.1 CITY OF RALEIGH COMMUNITY PROFILE

H.1.1 Geography and the Environment

Raleigh is a city located in Wake County in the state of North Carolina. It was incorporated in 1792 and serves as the capital of the state.

Overall, Wake County is known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Summer temperatures generally venture into the 90s for highs and cool off to the 70s at night. Winter temperatures in can drop to below freezing but generally highs are in the 50s. Rainfall is most common in the summer months but occurs consistently throughout the year.

H.1.2 Population and Demographics

According to the 2010 Census, Raleigh has a population of 403,892 people. The jurisdiction has seen exceptional growth between 2000 and 2010, and the population density is almost 2,900 people per square mile. Population counts from the US Census Bureau for 1990, 2000, and 2010 are presented in **Table H.1**.

TABLE H.1: POPULATION COUNTS FOR RALEIGH

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
RALEIGH	207,951	276,093	403,892	46.29%

Source: US Census Bureau

The racial characteristics of the jurisdiction are presented in **Table H.2**. Whites make up the majority of the population in the jurisdiction, although blacks and other races represent a strong share of the population as well.

TABLE H.2: DEMOGRAPHICS OF RALEIGH

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
RALEIGH	57.5%	29.3%	0.5%	12.7%	10.6%

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

H.1.3 Housing

According to the 2010 US Census, there are 176,124 housing units in Raleigh, the majority of which are single family homes or mobile homes. Housing information for the jurisdiction is presented in **Table H.3**.

TABLE H.3: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Seasonal Units, Percent (2010)	Median Home Value (2006-2010)
RALEIGH	120,699	176,124	7.5%	$208,000

Source: US Census Bureau

H.1.4 Infrastructure

Transportation

There are several major roadways that residents of Raleigh utilize. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs, one of which is I-440 which is a loop that surrounds the city and connects the jurisdiction to many of the other municipalities. In addition to the Interstate, there are many major highways that residents of the municipality utilize. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways in the include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities

Electrical power in the jurisdiction is provided by two entities and Duke Energy and Wake Electric Membership Corporation with Duke Energy providing service to a majority of the service. Water and sewer service is provided by two main entities as well: The City of Raleigh Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

Community Facilities

There are a number of buildings and community facilities located throughout Raleigh. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 31 fire stations, 16 police station, and 63 public schools located within the county. There are 4 medical care facilities located in the municipality.

Citizens also have access to several parks, including three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the county, including the American Tobacco Trail which is a rails to trails project that is open to a wide variety of non-motorized uses.

H.1.5 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land as parks. There are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the jurisdiction consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

H.1.6 Employment and Industry

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

H.2 CITY OF RALEIGH RISK ASSESSMENT

This subsection includes hazard profiles for each of the significant hazards identified in Section 4: *Hazard Identification* as they pertain to Raleigh. Each hazard profile includes a description of the hazard's location and extent, notable historical occurrences, and the probability of future occurrences. Additional information can be found in Section 5: *Hazard Profiles*.

H.2.1 Drought

Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, Raleigh has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that the county would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Historical Occurrences

According to the North Carolina Drought Monitor, Raleigh has had drought occurrences all of the last fourteen years (2000-2013). **Table H.4** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE H.4: HISTORICAL DROUGHT OCCURRENCES IN RALEIGH

Abnormally Dry **Moderate Drought** **Severe Drought** **Extreme Drought** **Exceptional Drought**

	Raleigh
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that Raleigh has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

H.2.2 Extreme Heat

Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to any geographic or political boundaries. All of Raleigh is susceptible to extreme heat conditions.

Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Raleigh. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the region. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the county. The most centralized location is in Raleigh at North Carolina State University. **Table H.5** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table H.5: Average Maximum Temperature in Raleigh, Wake County

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

H.2.3 Hailstorm

Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Raleigh is uniformly exposed to severe thunderstorms; therefore, all areas are equally exposed to hail which may be produced by such storms.

Historical Occurrences

According to the National Climatic Data Center, 55 recorded hailstorm events have affected Raleigh since 1993.[1] **Table H.6** is a summary of the hail events in Raleigh. **Table H.7** provides detailed information about each event that occurred. In all, hail occurrences resulted in over $0 (2013 dollars) in property damages. Hail ranged in diameter from 0.75 inches to 1.75 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value.

Table H.6: Summary of Hail Occurrences in Raleigh

Location	Number of Occurrences	Property Damage (2013)
Raleigh	55	$0

Source: National Climatic Data Center

[1] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Raleigh. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

TABLE H.7: HISTORICAL HAIL OCCURRENCES IN RALEIGH

	Date	Magnitude	Deaths/Injuries	Property Damage*
Raleigh				
Raleigh	3/27/1993	0.75 in.	0/0	$0
Raleigh	3/27/1993	0.75 in.	0/0	$0
Raleigh	5/19/1993	1 in.	0/0	$0
Raleigh	5/19/1993	0.75 in.	0/0	$0
RALEIGH, WAKE FOREST	5/29/1996	0.75 in.	0/0	$0
RALEIGH	7/31/1996	0.75 in.	0/0	$0
RALEIGH DURHAM ARPT	3/5/1997	1 in.	0/0	$0
NW RALEIGH	5/1/1997	0.75 in.	0/0	$0
2S RDU AIRPORT	5/1/1997	0.88 in.	0/0	$0
RALEIGH	5/1/1997	0.75 in.	0/0	$0
RALEIGH	5/1/1997	0.75 in.	0/0	$0
RALEIGH, CARY, RALEIGH	6/2/1997	1.75 in.	0/0	$0
RALEIGH	6/2/1997	0.75 in.	0/0	$0
NW RALEIGH	7/4/1997	1 in.	0/0	$0
N RALEIGH	7/16/1997	0.75 in.	0/0	$0
RALEIGH	5/8/1998	1 in.	0/0	$0
RALEIGH	5/27/1998	0.75 in.	0/0	$0
RALEIGH	6/15/1998	1.75 in.	0/0	$0
RALEIGH	6/23/1998	1 in.	0/0	$0
RALEIGH	7/4/1998	0.75 in.	0/0	$0
RALEIGH	7/6/1999	0.75 in.	0/0	$0
RALEIGH	5/28/2000	0.75 in.	0/0	$0
RALEIGH	6/3/2000	1 in.	0/0	$0
RALEIGH	6/14/2000	1.75 in.	0/0	$0
RALEIGH	7/17/2000	1.75 in.	0/0	$0
RALEIGH DURHAM ARPT	4/1/2001	0.75 in.	0/0	$0
RALEIGH	3/26/2002	0.88 in.	0/0	$0
RALEIGH	3/31/2002	0.88 in.	0/0	$0
RALEIGH	7/4/2002	0.75 in.	0/0	$0
RALEIGH	3/31/2004	0.88 in.	0/0	$0
RALEIGH	7/14/2004	0.88 in.	0/0	$0
RALEIGH	5/12/2005	1 in.	0/0	$0
RALEIGH	7/13/2005	2 in.	0/0	$0
RALEIGH	10/21/2005	4 in.	0/0	$0
RALEIGH	10/21/2005	0.75 in.	0/0	$0
RALEIGH	4/3/2006	0.88 in.	0/0	$0
RALEIGH	4/22/2006	1.75 in.	0/0	$0
RALEIGH	5/14/2006	1 in.	0/0	$0
RALEIGH	5/14/2006	1 in.	0/0	$0
RALEIGH	5/14/2006	1.75 in.	0/0	$0
RALEIGH	5/20/2006	0.75 in.	0/0	$0

	Date	Magnitude	Deaths/Injuries	Property Damage*
RALEIGH	5/20/2006	1.75 in.	0/0	$0
RALEIGH	5/20/2006	1 in.	0/0	$0
RALEIGH	5/25/2006	1 in.	0/0	$0
RALEIGH	6/6/2006	0.75 in.	0/0	$0
RALEIGH	6/11/2006	1 in.	0/0	$0
RALEIGH	7/27/2006	0.75 in.	0/0	$0
RALEIGH	4/11/2007	0.75 in.	0/0	$0
PURNELL	4/15/2007	0.75 in.	0/0	$0
RALEIGH	4/15/2007	0.88 in.	0/0	$0
RALEIGH	6/29/2007	0.75 in.	0/0	$0
RALEIGH	6/29/2007	0.88 in.	0/0	$0
RALEIGH	7/17/2007	0.75 in.	0/0	$0
RALEIGH	7/17/2007	1 in.	0/0	$0
RALEIGH	7/17/2007	1 in.	0/0	$0
RALEIGH	7/17/2007	0.75 in.	0/0	$0
RALEIGH	7/27/2007	1 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that Raleigh has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the county.

H.2.4 Hurricane and Tropical Storm

Location and Spatial Extent

Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Raleigh. The entire jurisdiction is equally susceptible to hurricane and tropical storms.

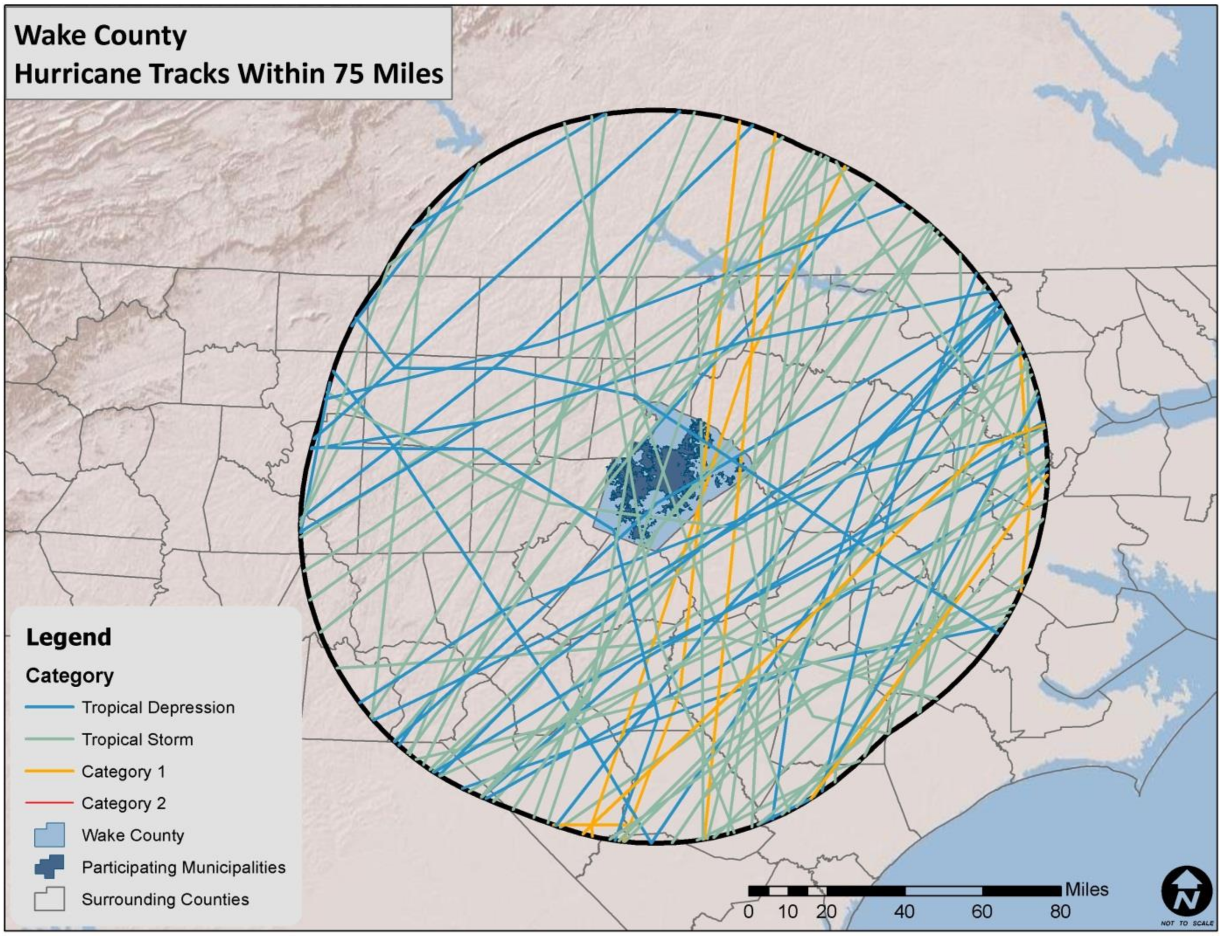
Historical Occurrences

According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[2] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms have traversed directly through Wake County as shown in **Figure H.1**. **Table H.8** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

[2] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

FIGURE H.1: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE H.8: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1
1882	NOT NAMED	53	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm
1959	CINDY	26	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression
2008	HANNA	40	Tropical Storm

Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Raleigh between 1950 and 2013. These storms are listed in **Table H.9** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE H.9: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made in 1996 (Hurricane Fran), 1999 (Hurricane Floyd), and 2003 (Hurricane Isabel) for the county.[3]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Tropical Storm Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

Probability of Future Occurrences
Given the inland location of the jurisdiction, it is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Raleigh. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the jurisdiction is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

[3] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

H.2.5 Lightning

Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Raleigh is uniformly exposed to lightning.

Historical Occurrences

According to the National Climatic Data Center, there have been six recorded lightning events in Raleigh since 1950, as listed in summary **Table H.10** and detailed in **Table H.11**.[4] However, it is certain that more lightning events have in fact impacted the jurisdiction. Many of the reported events are those that caused damage, and it should be expected that damages are likely much higher for this hazard than what is reported.

TABLE H.10: SUMMARY OF LIGHTNING OCCURRENCES IN RALEIGH

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Raleigh	6	0/0	$670,412

Source: National Climatic Data Center

TABLE H.11: HISTORICAL LIGHTNING OCCURRENCES IN RALEIGH

	Date	Deaths/Injuries	Property Damage*	Details
Raleigh				
Raleigh	7/10/1994	0/0	$87,785	A lightning strike entered a home on New Hope Road and shorted out the television set, causing the house to go up in flames.
Raleigh	7/17/1994	0/0	$87,785	Three house fires were caused by lightning.
N Raleigh	7/17/1995	0/0	$256,032	Lightning started a fire that destroyed a home.
RALEIGH	4/22/2006	0/0	$0	Numerous house fires reported throughout the county. At least four homes totally destroyed and 24 apartments in brier creek community destroyed.
RALEIGH	4/3/2006	0/0	$0	Lightning destroyed 3 apartment units.
RALEIGH	8/15/2008	0/0	$238,810	Two homes struck by lightning in the Raleigh caught fire resulting in extensive damage to each home.

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Raleigh. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

	Date	Deaths/Injuries	Property Damage*	Details

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences
Although there were not a high number of historical lightning events reported in Raleigh via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S. National Lightning Detection Network (NLDN®), Raleigh is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the jurisdiction.

H.2.6 Severe Thunderstorm/High Wind

Location and Spatial Extent
A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Also, Raleigh typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Raleigh has uniform exposure to an event and the spatial extent of an impact could be large.

Historical Occurrences
Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011.[5] According to NCDC, there have been 67 reported thunderstorm/high wind events since 1994 for high wind and since 1950 for thunderstorms.[6] These events caused over $164,000 (2013 dollars) in damages. **Table H.12** summarizes this information. **Table H.13** presents detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event.[7]

TABLE H. 12: SUMMARY OF THUNDERSTORM/HIGH WIND OCCURRENCES IN RALEIGH

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Raleigh	67	0/0	$164,787

Source: National Climatic Data Center

[5] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional thunderstorm events have occurred in Raleigh. As additional local data becomes available, this hazard profile will be amended.
[7] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

TABLE H.13: HISTORICAL THUNDERSTORM/HIGH WIND OCCURRENCES IN RALEIGH

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Raleigh					
Raleigh	8/17/1993	THUNDERSTORM WINDS	0 kts.	0/0	$0
Raleigh	7/17/1994	THUNDERSTORM WINDS	0 kts.	0/0	$0
NW Raleigh	7/18/1994	THUNDERSTORM WINDS	61 kts.	0/0	$0
RDU Airport	8/5/1994	THUNDERSTORM WIND	0 kts.	0/0	$0
N Raleigh	11/11/1995	THUNDERSTORM WINDS	0 kts.	0/0	$20,483
W Raleigh	11/11/1995	THUNDERSTORM WINDS	0 kts.	0/0	$0
RALEIGH	4/23/1996	TSTM WIND	0 kts.	0/0	$0
RALEIGH-DURHAM ARPT	5/11/1996	TSTM WIND	55 kts.	0/0	$82,869
RALEIGH	8/22/1996	TSTM WIND	50 kts.	0/0	$0
RALEIGH	11/8/1996	TSTM WIND	50 kts.	0/0	$0
RDU AIRPORT	2/21/1997	TSTM WIND	56 kts.	0/0	$0
RALEIGH	5/1/1997	TSTM WIND	50 kts.	0/0	$48,606
RALEIGH	6/15/1998	TSTM WIND	50 kts.	0/0	$0
RALEIGH	8/16/1998	TSTM WIND	50 kts.	0/0	$0
RALEIGH	8/14/1999	TSTM WIND	0 kts.	0/0	$0
RALEIGH	4/8/2000	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2000	TSTM WIND	60 kts.	0/0	$0
RALEIGH	8/18/2000	TSTM WIND	50 kts.	0/0	$0
RALEIGH	3/26/2002	TSTM WIND	50 kts.	0/0	$0
RALEIGH	8/24/2002	TSTM WIND	50 kts.	0/0	$0
RALEIGH	7/10/2003	TSTM WIND	50 kts.	0/0	$0
RALEIGH	3/7/2004	TSTM WIND	60 kts.	0/0	$0
RALEIGH	6/11/2004	TSTM WIND	50 kts.	0/0	$0
RALEIGH	7/29/2004	TSTM WIND	60 kts.	0/0	$0
RALEIGH	8/13/2004	TSTM WIND	50 kts.	0/0	$0
RALEIGH	9/17/2004	TSTM WIND	50 kts.	0/0	$0
RALEIGH DURHAM ARPT	9/17/2004	TSTM WIND	69 kts.	0/0	$0
RALEIGH	6/7/2005	TSTM WIND	50 kts.	0/0	$0
RALEIGH	7/28/2005	TSTM WIND	50 kts.	0/0	$0
RALEIGH	4/3/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	4/22/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	4/22/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/25/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/26/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	5/26/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	6/23/2006	TSTM WIND	50 kts.	0/0	$0
RALEIGH	7/27/2006	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	11/16/2006	THUNDERSTORM WIND	52 kts.	0/0	$0
RALEIGH DURHAM ARPT	3/2/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	6/9/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/17/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/17/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/17/2007	THUNDERSTORM WIND	51 kts.	0/0	$0
RALEIGH	7/17/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	8/10/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	8/21/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	8/21/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	3/4/2008	THUNDERSTORM WIND	61 kts.	0/0	$0
RALEIGH	7/6/2008	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/1/2009	THUNDERSTORM WIND	50 kts.	0/0	$1,159
RALEIGH	7/17/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/17/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/17/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	9/28/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/3/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/4/2012	THUNDERSTORM WIND	50 kts.	0/0	$1,061
RALEIGH	7/23/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
RALEIGH	7/24/2012	THUNDERSTORM	50 kts.	0/0	$0

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
		WIND			
RALEIGH	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$10,609
(RDU)RALEIGH-DURHAM	7/28/2012	THUNDERSTORM WIND	57 kts.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire jurisdiction.

H.2.7 Tornado

Location and Spatial Extent

Tornadoes occur throughout the state of North Carolina, and thus in Raleigh. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Raleigh is uniformly exposed to this hazard.

Historical Occurrences

Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there have been two recorded tornado events in Raleigh since 1956 (**Table H.14**), resulting in nearly $25,000 (2013 dollars) in property damages.[8] Detailed information on these events can be found in **Table H.15**. The greatest magnitude of these tornadoes was a F0 in intensity, although an F5 event is possible. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is likely that a high number of occurrences have gone unreported over the past 50 years.

TABLE H.14: SUMMARY OF TORNADO OCCURRENCES IN RALEIGH

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Raleigh	2	0/0	$23,930

Source: National Climatic Data Center

TABLE H.15: HISTORICAL TORNADO IMPACTS IN RALEIGH

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Raleigh					
Raleigh	3/27/1993	F0	0/0	$0	A small tornado touched down briefly

[8] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Raleigh. As additional local data becomes available, this hazard profile will be amended.

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
					south of Lake Wheeler and moved northward blowing down trees in its path.
Raleigh	3/20/1998	F0	0/0	$23,930	The storm that hit Garner produced another tornado 6 miles to the northeast on the east side of Raleigh. Damage began just off US64 at Wake Medical Center and the Tower Shopping Center. Cars were overturned, trees were damaged, and a steel-beamed billboard was twisted. The tornado then crossed the highway where it lifted the roof off the business office of a tree nursey, damaged two sheds, and destroyed 5 greenhouses. Insulation and debris was strewn up in the trees well away from the path.

*Property Damage is reported in 2013 dollars.
Source: NCDC

Probability of Future Occurrences

According to historical information, tornado events are not an annual occurrence for the jurisdiction. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Raleigh experience a direct tornado strike. The probability of future tornado occurrences affecting Raleigh is likely (10-100 percent annual probability).

H.2.8 Winter Storm and Freeze

Location and Spatial Extent

Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Raleigh is accustomed to smaller scale severe winter weather conditions and often receives severe winter weather during the winter months. Given the atmospheric nature of the hazard, the entire jurisdiction has uniform exposure to a winter storm.

Historical Occurrences

Severe winter weather has resulted in six disaster declarations in Raleigh. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. [9] According to the National Climatic Data Center, there have been no recorded winter storm events in Raleigh since 1993 (**Table H.16**).[10] These events resulted in $0 (2013 dollars) in damages. However, there have been

[9] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[10] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional winter storm conditions have affected Raleigh.

28 recorded countywide events and most severe winter weather events are only recorded at the county level.

TABLE H.16: SUMMARY OF WINTER STORM EVENTS IN RALEIGH

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Raleigh	0	0/0	$0

Source: National Climatic Data Center

There have been several severe winter weather events in Raleigh. The text below describes one of the major events and associated impacts on the county. Similar impacted can be expected with severe winter weather.

1996 Winter Storm

This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and power outages. Furthermore, citizens may resort to using inappropriate heating devices that could to fire or an accumulation of toxic fumes.

<u>Probability of Future Occurrences</u>

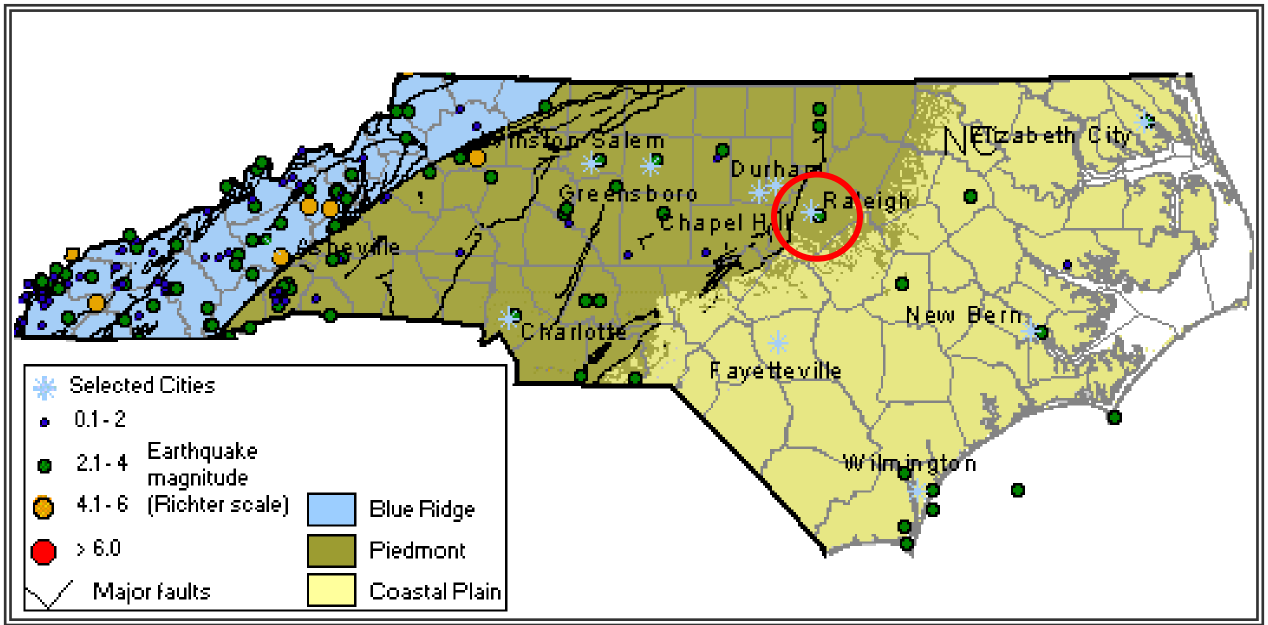
Winter storm events will remain a somewhat regular occurrence in Raleigh due to location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

H.2.9 Earthquake

<u>Location and Spatial Extent</u>

Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina. **Figure H.2** is a map showing geological and seismic information for North Carolina.

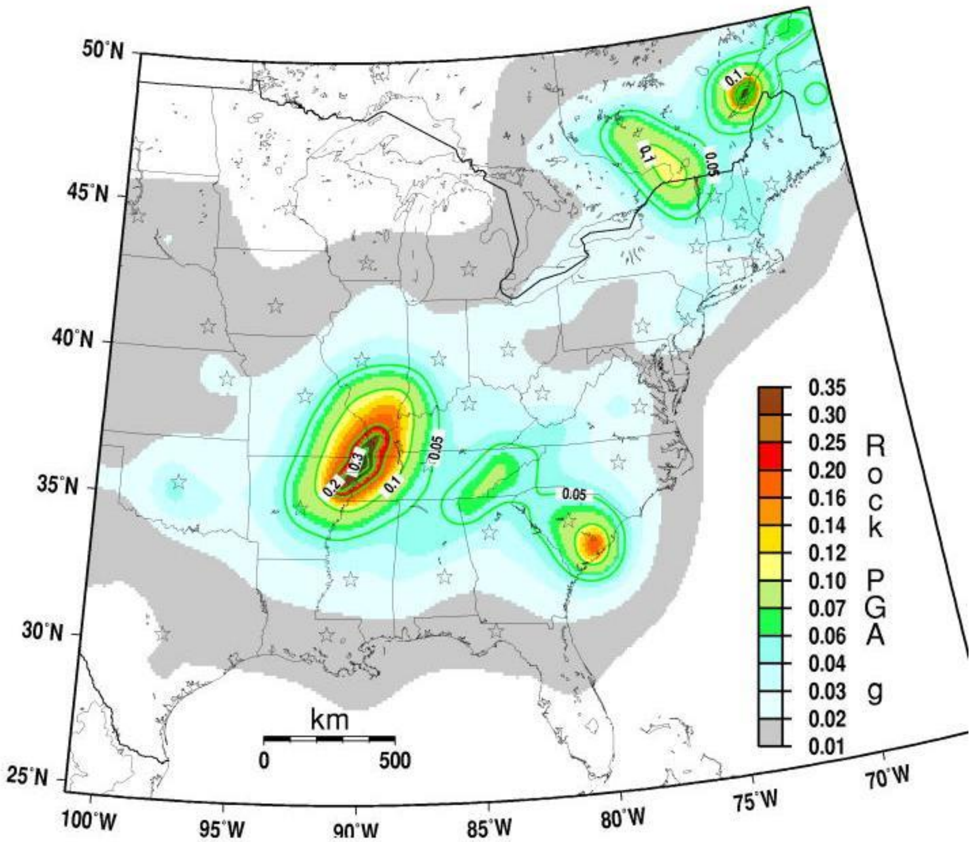
FIGURE H.2: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure H.3 shows the intensity level associated with Raleigh, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Raleigh lies within an approximate zone of level "2" to "3" ground acceleration. This indicates that the county exists within an area of moderate seismic risk.

FIGURE H.3: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

Historical Occurrences

Thirteen earthquakes are known to have occurred directly in Raleigh since 1874. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table H.17** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table H.18** presents a detailed occurrence of each event including the date, distance for the epicenter, and Modified Mercalli Intensity (if known).[11]

TABLE H.17: SUMMARY OF SEISMIC ACTIVITY IN RALEIGH

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Raleigh	13	VIII	7.2

Source: National Geophysical Data Center

[11] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

TABLE H.18: SIGNIFICANT SEISMIC EVENTS IN RALEIGH (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI (magnitude)
Raleigh				
Raleigh	12/16/1811	987.0	7.2	4
Raleigh	1/23/1812	987.0	7.1	2
Raleigh	3/10/1828			5
Raleigh	8/27/1833			3
Raleigh	4/29/1852			3
Raleigh	9/1/1886	343.0		8
Raleigh	9/1/1886	343.0		7
Raleigh	5/31/1897	249.0		3
Raleigh	11/25/1898			4
Raleigh	1/1/1913	302.0		3
Raleigh	3/5/1914	511.0		3
Raleigh	2/21/1916	350.0		2
Raleigh	11/20/1969	277.0	4.3	4

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Raleigh, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table H.19.**

TABLE H.19: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 - 1	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928*	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957*	Buncombe County, NC	3.7	VI	VI
11/24/1957*	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973*	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Raleigh occurrences.
** Conflicting reports on this event, intensity in North Carolina could have been either V or VI
Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Raleigh is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. The annual probability level for the county is estimated between 1 and 10 percent (possible).

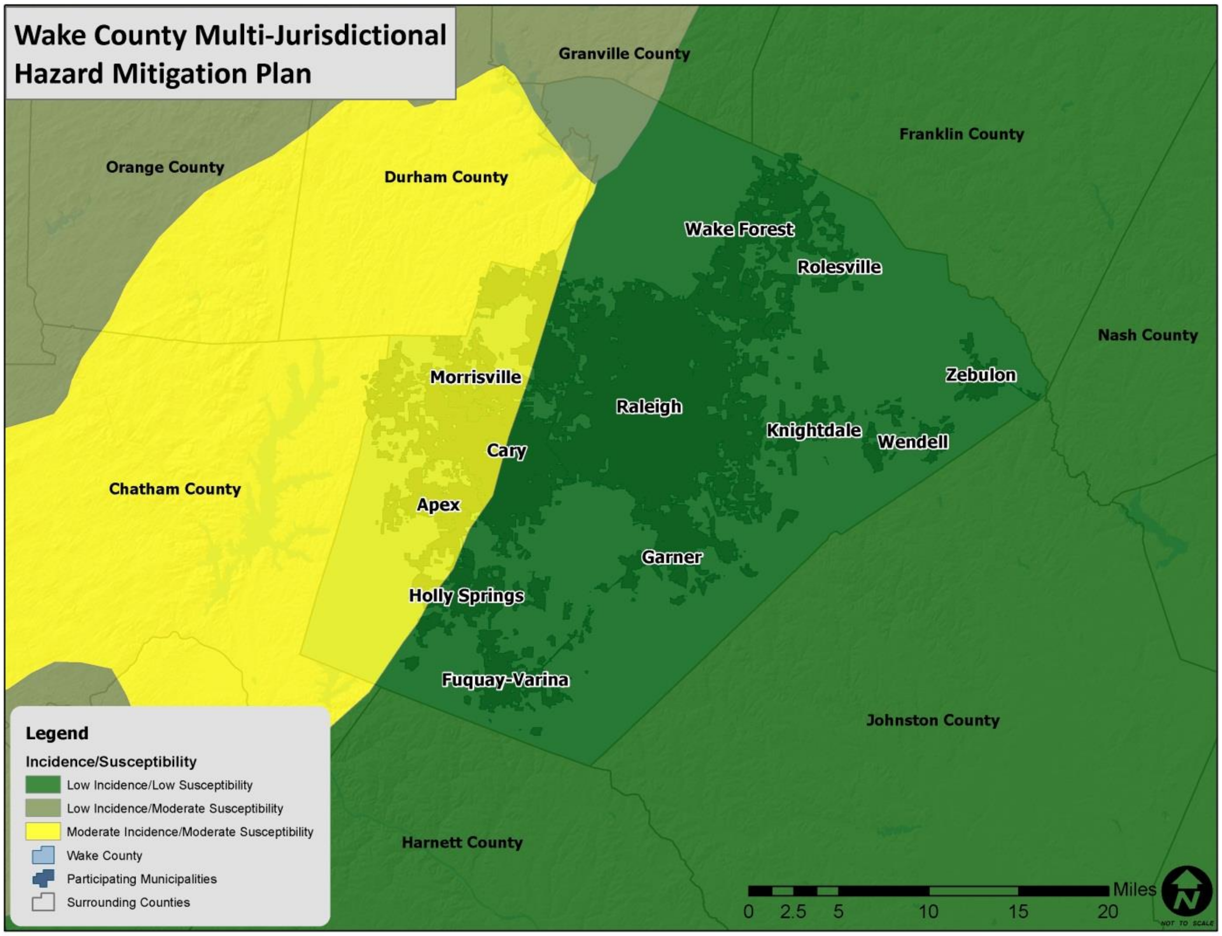
H.2.10 Landslide

Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Raleigh, although the overall risk is relatively low.

According to **Figure H.4** below, the majority of the county has low landslide activity. However there is a small area along the western border of the county (which includes parts of Raleigh) that has a moderate incidence and moderate susceptibility. In all other areas, there is low susceptibility.

FIGURE H.4: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

Historical Occurrences

Steeper topography in some areas of Raleigh make the planning area susceptible to landslides. Most landslides are caused by heavy rainfall in the area. Building on steep slopes that was not previously possible also contributes to risk. **Table H.20** presents a summary of the landslide occurrence events as provided by the North Carolina Geological Survey[12]. The georeferenced locations of the landslide events presented in the aforementioned tables are presented in **Figure H.5**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred in Raleigh.

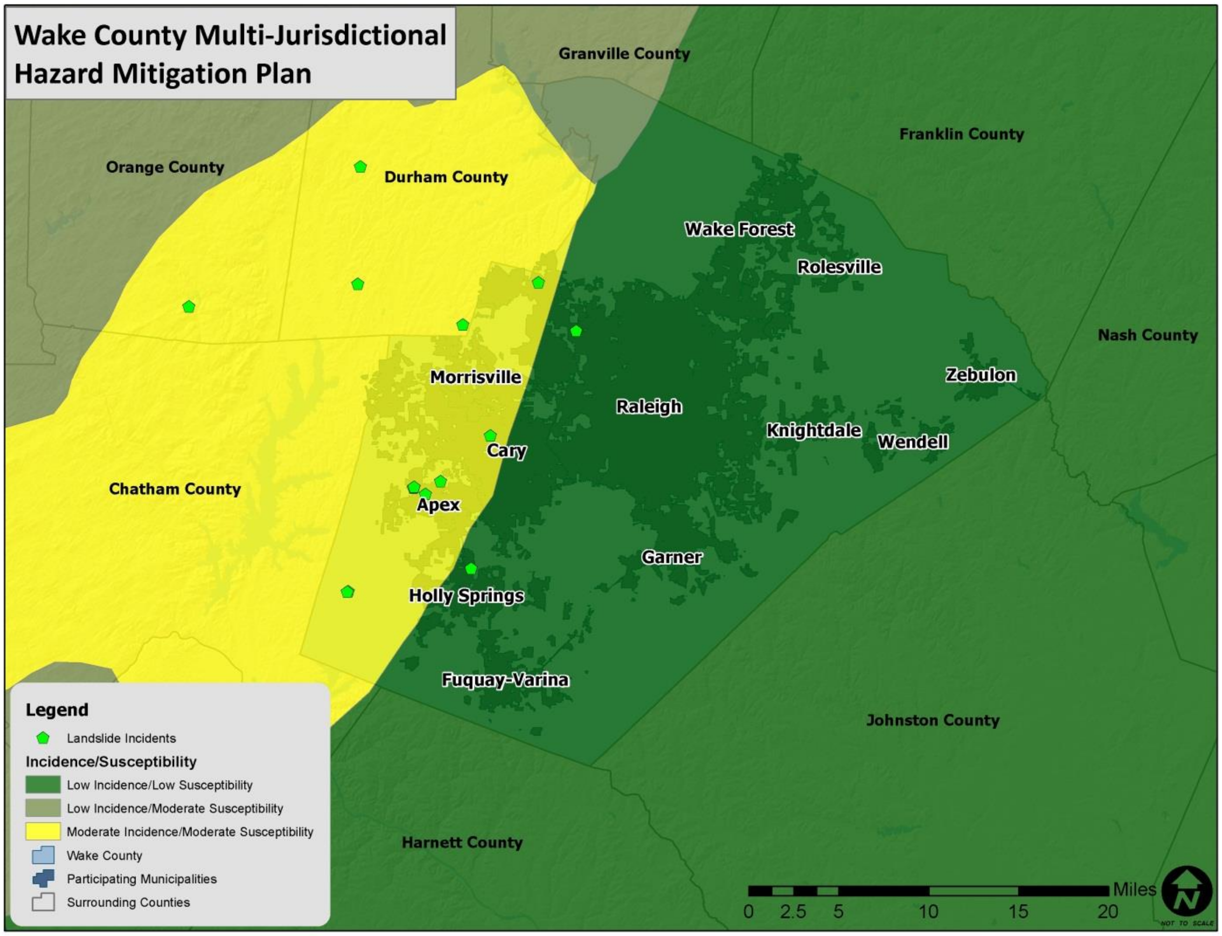
TABLE H.20: SUMMARY OF LANDSLIDE ACTIVITY IN RALEIGH

Location	Number of Occurrences
Raleigh	2

[12] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

Source: North Carolina Geological Survey

FIGURE H.5: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Raleigh have greater risk than others given factors such as steepness on slope and modification of slopes.

H.2.11 Dam and Levee Failure

Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table H.21** explains these classifications.

TABLE H.21: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

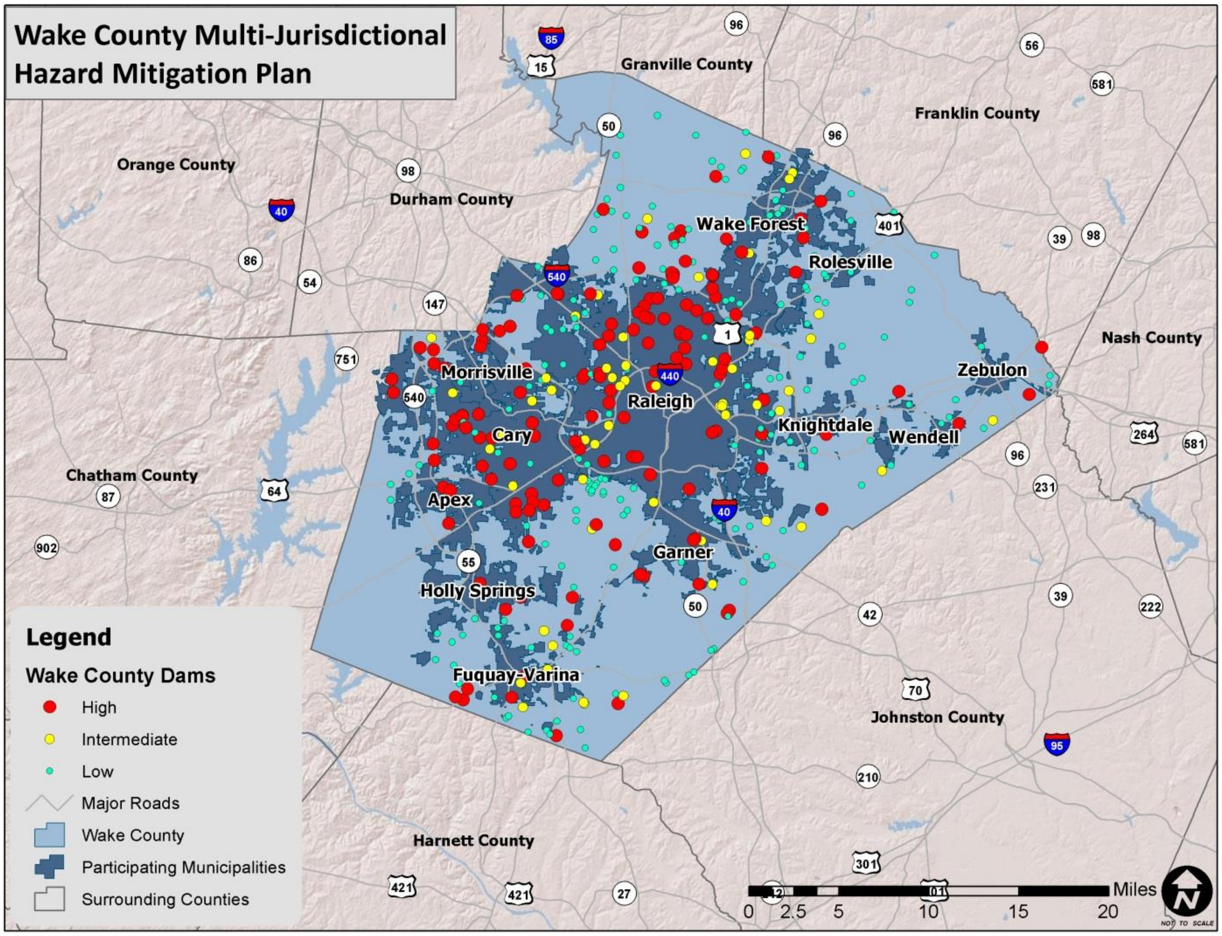
Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

According to the North Carolina Division of Land Management there are 98 dams in Raleigh.[13] **Figure H.6** shows the dam location and the corresponding hazard ranking for each. Of these dams, fifty-seven are classified as high hazard potential. These high hazard dams are listed in **Table H.22**.

[13] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE H.6: WAKE COUNTY DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE H.22: RALEIGH HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Raleigh				
Shelley Lake	High	53	4269	Local Gov
Lake Lynn	High	55.7	2292	Local Gov
Eastgate Park Dam	High	3	27	Local Gov
Crabtree Creek W/S Structure #11a	High	44.5	3327	Local Gov
E.M. Johnson Water Plant B	High	13.1	383	Local Gov
E.M. Johnson Plant A Dam	High	6.4	110	Local Gov
Hedingham Dam #1	High	14.8	152	Private
Gresham Lake Dam	High	65	1755	Private
Shaw Lake Dam	High	4	55	Private
Baker Lake Dam	High	5	60	Private
Turfgrass Lake Dam #3	High	11	85	Private
Lakes Apartment Dam	High	3	21.6	Private
Brentwood Today Lake Dam	High	0	12	Private

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Em Johnson Alum Sludge Lagoon Dam	High	6	108.3	Private
Alyson Pond	High	0	40	Private
Lakemont Dam	High	8.3	91	Private
Cedar Hills Lake Dam	High	0	20	Private
Northshore Lake Dam	High	8	63	Private
Bullard And Patterson Dam	High	0.75	2.5	Private
Camp Pond Dam	High	4	24	Private
Wooten Pond Dam	High	0	40	Private
Ammons Lake Dam Upper	High	0	50	Private
Ammons Lake Dam Lower	High	8	352	Private
Longview Lake Dam Lower	High	12	143	Private
Longview Lake Upper Dam	High	5.5	44	Private
North Ridge Lake Dam Upper	High	15	168	Private
North Ridge Lake Dam Lower	High	0	161	Private
North Blvd Comm Center Dam	High	0	20	Private
Hart-George Pond	High	2	18	Private
Williams-Johnson Pond Dam	High	0	44	Private
The Lakes Lower Dam	High	5	41	Private
Summer Lake Dam	High	4.3	18	Private
Meredith College Dam	High	3	34	Private
Underwood Dam	High	3.1	30	Private
Ward Transformer Dike	High	0	13	Private
Martin Marietta #1 Dam	High	3.6	59	Private
Lakeside Dam	High	3	23	Private
Leadmine Lake Dam	High	10	92	Private
Delta Lake	High	3	42	Private
Olde Raleigh Dam #3	High	2.8	24	Private
Olde Raleigh Dam #1	High	1.6	19.7	Private
Olde Raleigh Dam #2	High	3.2	25.1	Private
Landmark Apts. Dam	High	2	18	Private
Remington Park Dam	High	6	84	Private
Newton Commons Dam	High	0.75	8.6	Private
Lake Plaza Dam	High	2	18.4	Private
Lake Raleigh Dam	High	66	781	State
Lake Johnson Dam	High	147.5	3090	Utility
Carolina Country Club Water Harvesting Pond Dam	High	0	0	
Raintree Lake	High	0	0	
NCSU Centennial Campus Farm Pond Dam	High	2	20	
Heathrow Dam	High	0	26	
Mallard Pond Dam	High	0	8	
Art Museum Dam	High	0	10	
Brier Creek Village Center Dam	High	0	0	
Carolina Pines Dam	High	4.3	53	
Bedford at Falls River Dam #1	High	0	4	

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type

Source: North Carolina Division of Land Resources, 2012

It should also be noted that the North Carolina dam classification regulations were recently updated. As a result of the change, more dams are generally classified as high hazard.

Historical Occurrences

Two dam breaches were reported in Raleigh. Both occurred in 1996 at Lake Raleigh and Silver Lake during Hurricane Fran.

Probability of Future Occurrences

Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

H.2.12 Erosion

Location and Spatial Extent

Erosion in Raleigh is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Raleigh soils have greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Raleigh, particularly along the banks of rivers and streams, but it is not an extreme threat. No areas of concern were reported by the planning committee.

Historical Occurrences

Several sources were vetted to identify areas of erosion in Raleigh. This includes searching local newspapers, interviewing local officials, and reviewing the previous hazard mitigation plan. Little information could be found and erosion was not addressed in the previous Raleigh hazard mitigation plan.

Probability of Future Occurrences

Erosion remains a natural, dynamic, and continuous process for Raleigh, and it will continue to occur. The annual probability level assigned for erosion is possible (between 1 and 10 percent annually).

H.2.13 Flood

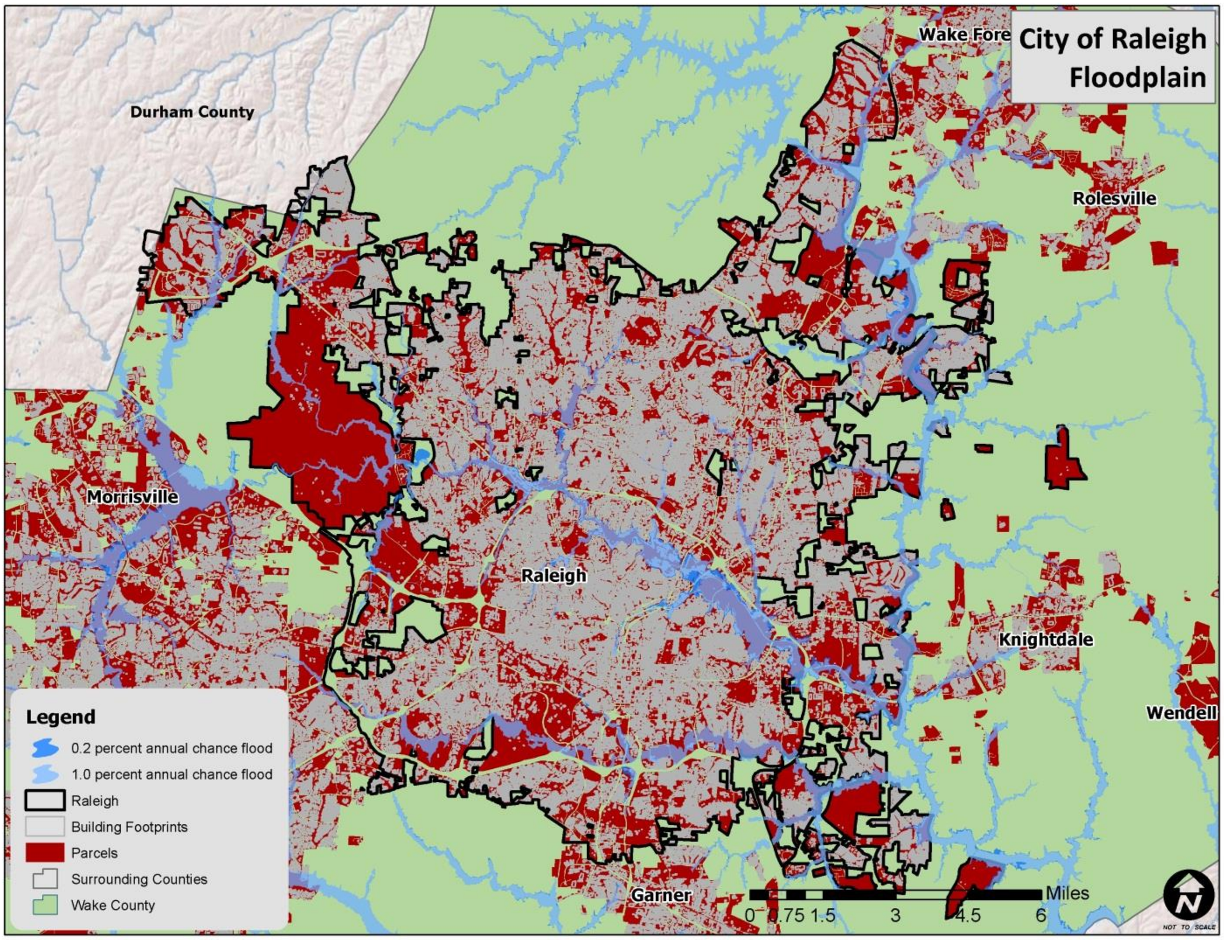
Location and Spatial Extent

There are areas in Raleigh that are susceptible to flood events. Special flood hazard areas in the jurisdiction were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[14] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 145 square miles that make up Raleigh, there are 11.35 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain).

[14] The county-level DFIRM data used for Raleigh were updated in 2010.

These flood zone values account for 7.8 percent of the total land area in Raleigh. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas. **Figure H.7** illustrates the location and extent of currently mapped special flood hazard areas for Raleigh based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.

FIGURE H.7: SPECIAL FLOOD HAZARD AREAS IN RALEIGH



Source: Federal Emergency Management Agency

Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported a total of 36 events in Raleigh since 1993.[15] A summary of these events is presented in **Table H.23**. These events accounted for over $10,416,787 (2013 dollars) in property damage in the county.[16] Specific information on flood events, including date, type of flooding, and deaths and injuries, can be found in **Table H.24**.

[15] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.
[16] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

Table H.23: Summary of Flood Occurrences in Raleigh

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Raleigh	36	0/0	$10,416,787

Source: National Climatic Data Center

Table H.24: Historical Flood Events in Raleigh

	Date	Type	Deaths/ Injuries	Property Damage*
Raleigh				
NE Raleigh	8/27/1995	FLASH FLOODING	0/0	$10,241298
Raleigh	10/4/1995	FLASH FLOOD	0/0	$0
RALEIGH	9/6/1996	FLASH FLOOD	0/0	$0
RALEIGH	9/10/1996	FLASH FLOOD	0/0	$0
RALEIGH, WENDELL	9/10/1996	FLASH FLOOD	0/0	$0
RALEIGH	9/11/1996	FLASH FLOOD	0/0	$0
RALEIGH	10/8/1996	FLASH FLOOD	0/0	$0
RALEIGH	4/28/1997	FLASH FLOOD	0/0	$0
RALEIGH	1/16/1998	FLASH FLOOD	0/0	$79,768
RALEIGH	1/23/1998	URBAN/SML STREAM FLD	0/0	$0
RALEIGH	3/9/1998	FLASH FLOOD	0/0	$0
RALEIGH	3/19/1998	FLASH FLOOD	0/0	$0
RALEIGH	8/8/1998	URBAN/SML STREAM FLD	0/0	$31,907
RALEIGH	8/16/1998	URBAN/SML STREAM FLD	0/0	$63,814
RALEIGH	7/29/2000	FLASH FLOOD	0/0	$0
RALEIGH	8/1/2000	FLASH FLOOD	0/0	$0
RALEIGH	8/4/2000	FLASH FLOOD	0/0	$0
RALEIGH	9/3/2000	FLASH FLOOD	0/0	$0
RALEIGH	9/4/2000	FLASH FLOOD	0/0	$0
RALEIGH	9/25/2000	FLASH FLOOD	0/0	$0
RALEIGH	3/31/2002	FLASH FLOOD	0/0	$0
RALEIGH	6/28/2002	FLASH FLOOD	0/0	$0
RALEIGH	8/26/2002	FLASH FLOOD	0/0	$0
RALEIGH	10/11/2002	FLASH FLOOD	0/0	$0
RALEIGH	6/7/2003	FLASH FLOOD	0/0	$0
RALEIGH	7/29/2003	FLASH FLOOD	0/0	$0
RALEIGH	8/13/2004	FLASH FLOOD	0/0	$0
RALEIGH	8/30/2004	FLASH FLOOD	0/0	$0
RALEIGH	6/7/2005	FLASH FLOOD	0/0	$0
RALEIGH	6/7/2005	FLASH FLOOD	0/0	$0
RALEIGH	6/23/2006	FLASH FLOOD	0/0	$0
RALEIGH	6/16/2009	FLASH FLOOD	0/0	$0
RALEIGH	1/25/2010	FLASH FLOOD	0/0	$0
RALEIGH	9/30/2010	FLASH FLOOD	0/0	$0
RALEIGH	9/30/2010	FLASH FLOOD	0/0	$0
RALEIGH	8/6/2011	FLASH FLOOD	0/0	$0

Source: National Climatic Data Center

Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there have been 725 flood losses reported in Raleigh through the National Flood Insurance Program (NFIP) since 1978. A summary of these figures for the jurisdiction is provided in **Table H.25**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that additional instances of flood loss in Raleigh were either uninsured, denied claims payment, or not reported.

TABLE H.25: SUMMARY OF INSURED FLOOD LOSSES IN RALEIGH

Location	Flood Losses	Claims Payments
Raleigh	725	$18,503,795

Source: FEMA, NFIP

Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

As of July 2013, there are 109 non-mitigated repetitive loss properties located in Raleigh, which accounted for 316 losses and $11,500,659 in claims payments under the NFIP. Without mitigation, repetitive loss properties will likely continue to experience flood losses. **Table H.26** presents detailed information on repetitive loss properties and NFIP claims and policies for Raleigh.

TABLE H.26: SUMMARY OF REPETITIVE LOSS PROPERTIES IN RALEIGH

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Raleigh	109	54 single family, 23 multi-family residential, 32 non-residential,	316	$8,969,656	$2,531,003	$11,500,659	$36,394

Source: National Flood Insurance Program

Probability of Future Occurrences

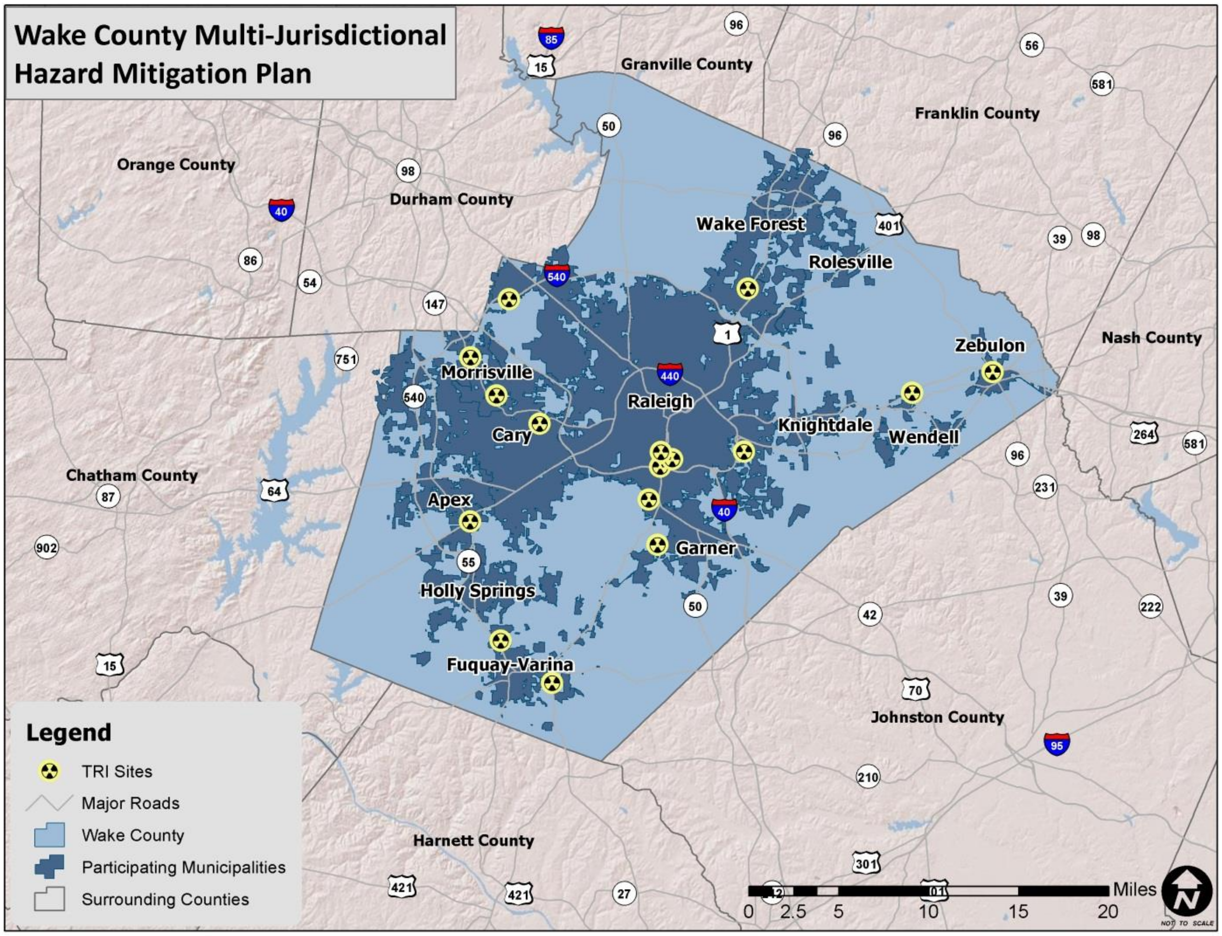
Flood events will remain a threat in areas prone to flooding in Raleigh, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability) The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above**,** which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

H.2.14 Hazardous Materials Incidents

Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Raleigh has twelve TRI sites. These sites are shown in **Figure H.8.**

FIGURE H.8: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the jurisdiction via roadways and rail. All roads that permit hazardous material transport are considered potentially at risk to an incident.

Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,

- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table H.27 presents detailed information on historic HAZMAT incidents reported in Raleigh.

TABLE H.27: SUMMARY OF HAZMAT INCIDENTS IN RALEIGH

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Raleigh							
I-1977080716	7/30/1977	RALEIGH	Rail	No	0/0	$0	75 LGA
I-1978110327	11/1/1978	RALEIGH	Highway	No	0/0	$0	0
I-1979100080	9/26/1979	RALEIGH	Highway	No	0/0	$0	0
I-1981010515	12/11/1980	RALEIGH	Highway	No	0/0	$0	0
I-1981060498	6/1/1981	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1981060461	6/5/1981	RALEIGH	Highway	No	0/0	$0	0
I-1981070578	6/29/1981	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1981070804	7/15/1981	RALEIGH	Highway	No	0/0	$0	0
I-1981100173	9/24/1981	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1982040236	3/31/1982	RALEIGH	Highway	No	0/0	$0	4 LGA
I-1983070353	7/13/1983	RALEIGH	Highway	No	0/0	$0	0
I-1983110081	10/12/1983	RALEIGH	Highway	No	0/0	$0	0
I-1984020005	1/27/1984	RALEIGH	Highway	No	0/0	$0	0.084 LGA
I-1984020007	1/31/1984	RALEIGH	Highway	No	0/0	$0	0.028 LGA
I-1984060124	5/29/1984	RALEIGH	Highway	No	0/0	$0	0.75 LGA
I-1984070014	6/20/1984	RALEIGH	Highway	No	0/0	$0	0.75 LGA
I-1984080225	7/30/1984	RALEIGH	Highway	No	0/0	$0	0.028 LGA
I-1984100136	9/20/1984	RALEIGH	Highway	No	0/0	$0	2 LGA
I-1984100442	10/5/1984	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1984110124	10/26/1984	RALEIGH	Highway	No	0/0	$0	0.025 LGA
I-1985010128	12/18/1984	RALEIGH	Highway	No	0/0	$0	0.063 LGA
I-1985020178	1/25/1985	RALEIGH	Highway	No	0/1	$0	0.063 LGA
I-1985020241	2/1/1985	RALEIGH	Highway	No	0/0	$0	6 LGA
I-1985030198	2/26/1985	RALEIGH	Highway	No	0/0	$0	2 LGA
I-1985030265	3/4/1985	RALEIGH	Highway	No	0/0	$0	0.25 LGA
I-1985050360	5/7/1985	RALEIGH	Highway	No	0/0	$0	0.12 LGA
I-1985060205	5/29/1985	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1985100019	9/16/1985	RALEIGH	Highway	No	0/0	$0	11.03 SLB
I-1986030006	2/17/1986	RALEIGH	Highway	No	0/0	$0	0.5 LGA
I-1986070259	6/26/1986	RALEIGH	Highway	No	0/0	$0	2.5 LGA

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
I-1986080269	7/29/1986	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1986100005	9/16/1986	RALEIGH	Highway	No	0/0	$0	0.1 LGA
I-1987070563	7/1/1987	RALEIGH	Highway	No	0/0	$0	0
I-1987100297	9/24/1987	RALEIGH	Highway	No	0/0	$0	3.63 LGA
I-1987100321	10/6/1987	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1987100343	10/7/1987	RALEIGH	Highway	No	0/0	$0	5 LGA
I-1988010146	12/18/1987	RALEIGH	Highway	No	0/0	$0	0.028 LGA
I-1988010148	12/22/1987	RALEIGH	Highway	No	0/0	$0	0.25 LGA
I-1988080461	7/21/1988	RALEIGH	Highway	No	0/0	$0	30 LGA
I-1989020160	1/31/1989	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1990030107	1/26/1990	RALEIGH	Air	No	0/0	$0	0
I-1990030232	2/20/1990	RALEIGH	Highway	No	0/0	$0	5 LGA
I-1990120159	10/25/1990	RALEIGH	Highway	No	0/0	$0	50 LGA
I-1993081588	8/2/1993	RALEIGH	Air	No	0/0	$0	0.039063 LGA
I-1993081357	8/2/1993	RALEIGH	Highway	No	0/0	$0	0
I-1993100673	8/9/1993	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1994080300	7/21/1994	RALEIGH	Rail	Yes	0/0	$0	40000 SLB
I-1994101389	10/18/1994	RALEIGH	Highway	No	0/0	$0	50 LGA
I-1995100985	4/14/1995	RALEIGH	Highway	No	0/0	$0	1.056688 LGA
I-1995071497	4/28/1995	RALEIGH	Highway	No	0/0	$0	0.03125 LGA
I-1995071494	5/8/1995	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1995071554	5/25/1995	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1995101404	6/27/1995	RALEIGH	Highway	No	0/0	$0	0.25 LGA
I-1995071499	7/12/1995	RALEIGH	Highway	No	0/0	$0	0.015625 LGA
I-1995120430	11/1/1995	RALEIGH	Highway	No	0/0	$0	0.015625 LGA
I-1996020469	1/16/1996	RALEIGH	Highway	No	0/0	$0	1 LGA
I-1996071223	7/23/1996	RALEIGH	Highway	No	0/0	$0	0.023438 LGA
I-1996080443	7/30/1996	RALEIGH	Highway	No	0/0	$0	0.078125 LGA
I-1996080442	8/5/1996	RALEIGH	Highway	No	0/0	$0	0.25 LGA
I-1996090297	8/29/1996	RALEIGH	Highway	No	0/0	$0	0.007813 LGA
I-1996110026	10/29/1996	RALEIGH	Air	No	0/0	$0	0.007925 LGA
I-1996120028	11/25/1996	RALEIGH	Highway	No	0/0	$0	10 SLB
I-1997040453	3/4/1997	RALEIGH	Highway	No	0/0	$0	0.125 LGA
I-1997040455	3/11/1997	RALEIGH	Highway	No	0/0	$0	0.125 LGA
I-1997040454	3/11/1997	RALEIGH	Highway	No	0/0	$0	0.125 LGA
I-1997100264	9/24/1997	RALEIGH	Air	No	0/0	$0	0
I-1999100328	9/9/1999	RALEIGH	Highway	No	0/0	$0	4 LGA
I-2000121256	7/17/2000	RALEIGH	Highway	No	0/0	$0	0.015625 LGA
I-2000110296	7/17/2000	RALEIGH	Highway	No	0/0	$0	1 LGA
I-2000091202	9/7/2000	RALEIGH	Air	No	0/0	$0	0
I-2001081264	8/14/2001	RALEIGH	Air	No	0/0	$0	0.007925 LGA
I-2002021296	12/4/2001	RALEIGH	Highway	No	0/0	$0	1 LGA
I-2002100659	9/21/2002	RALEIGH	Air	No	0/0	$0	0.528344 LGA
I-2003020893	2/7/2003	RALEIGH	Highway	No	0/0	$0	0.000011 SLB
I-2003040684	4/1/2003	RALEIGH	Highway	No	0/0	$0	1.41 LGA
I-2003080356	7/21/2003	RALEIGH	Highway	No	0/0	$0	1.5 LGA

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
I-2004061482	6/11/2004	RALEIGH	Highway	No	0/0	$0	2 SLB
I-2004070869	6/23/2004	RALEIGH	Highway	No	0/0	$0	0.000654 LGA
I-2004071381	7/8/2004	RALEIGH	Highway	No	0/0	$0	0.007813 LGA
I-2004100076	9/24/2004	RALEIGH	Highway	No	0/0	$0	0.132086 LGA
I-2005050548	5/11/2005	RALEIGH	Highway	No	0/0	$0	0.25 LGA
I-2006050673	4/17/2006	RALEIGH	Highway	No	0/0	$0	0.007812 LGA
I-2006060671	5/16/2006	RALEIGH	Highway	No	0/0	$0	0.015625 LGA
I-2006090269	7/27/2006	RALEIGH	Highway	No	0/0	$0	0.023438 LGA
I-2007051141	4/26/2007	RALEIGH	Highway	No	0/0	$0	0.5 LGA
I-2007090012	8/1/2007	RALEIGH	Highway	No	0/0	$0	2 LGA
I-2007100362	10/4/2007	RALEIGH	Highway	No	0/0	$0	0.125 LGA
E-2008050190	4/25/2008	RALEIGH	Rail	No	0/0	$0	5 LGA
I-2008090672	8/8/2008	RALEIGH	Highway	No	0/0	$0	25 LGA
I-2011070414	7/7/2011	RALEIGH	Highway	No	0/0	$0	0.066045 LGA
E-2013040047	3/15/2013	RALEIGH	Highway	No	0/0	$0	8 SLB

Source: USDOT PHMSA

Probability of Future Occurrences

Given the location of twelve toxic release inventory sites in Raleigh and several roadways and rails that transport hazardous materials, it is possible that a hazardous material incident may occur in the jurisdiction (between 1 percent and 10 percent annual probability). Local officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

H.2.15 Wildfire

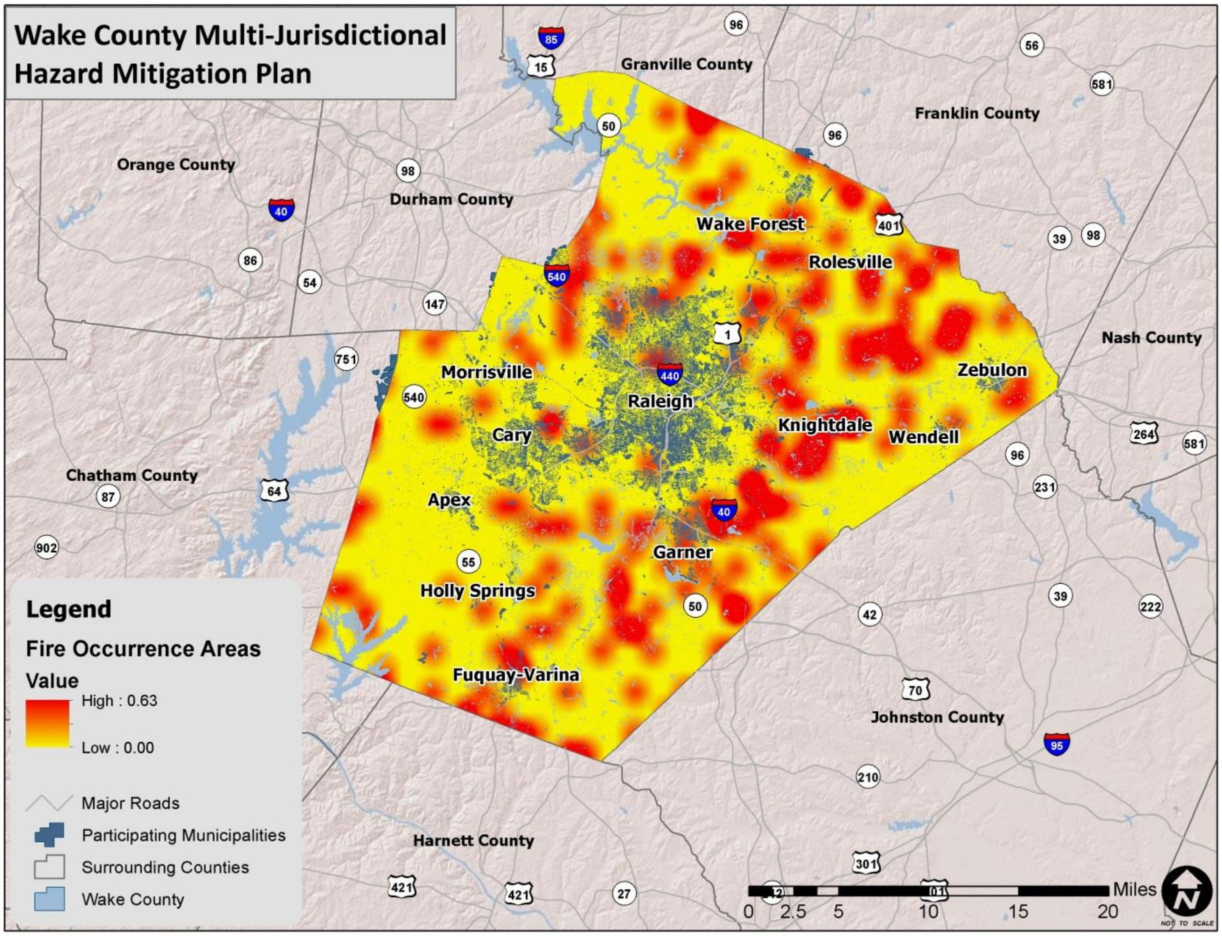
Location and Spatial Extent

The entire jurisdiction is at some risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas.

Historical Occurrences

Figure H.9 shows the Fire Occurrence Areas (FOA) in Raleigh based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. Therefore, even areas classified as at relatively high risk within the county are a relatively low risk compared to other areas of the state.

FIGURE H.9: HISTORIC WILDFIRE EVENTS IN RALEIGH



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of 16 wildfires annually which burn an average of 98 acres per year. The data indicates that most of these fires are small, averaging six acres per fire. **Table H.28** lists the number of reported wildfire occurrences in the county between the years 2003 and 2012.

TABLE H.28: HISTORICAL WILDFIRE OCCURRENCES IN RALEIGH

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Raleigh. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Raleigh for future wildfire events is possible (a 1 and 10 percent annual probability).

H.2.16 Nuclear Accident

Location and Spatial Extent

The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station.

Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 "Alerts" and 28 "Notice of Unusual Events" since 1986, which are shown in **Table H.29**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table H.29: SHEARON HARRIS EMERGENCY DECLARATION HISTORY

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on "B" Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).

Emergency Declaration	Date	Description
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of "A" Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - "B" diesel generator was being worked on; in accordance with test procedures, "A" diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported "Notice of Unusual Events" since 1986, which is shown in **Table H.30**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table H.30: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Probability of Future Occurrences
A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

H.2.17 Terror Threat

Location and Spatial Extent
A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table H.31** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

TABLE H.31 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food ▪ Banking and Finance ▪ Chemical ▪ Commercial Facilities ▪ Communications ▪ Critical Manufacturing ▪ Dams ▪ Defense Industrial Base ▪ Emergency Services ▪ Energy	▪ Government Facilities ▪ Healthcare and Public Health ▪ Information Technology ▪ National Monuments and Icons ▪ Nuclear Reactors, Materials, and Waste ▪ Postal and Shipping ▪ Transportation Systems ▪ Water

Historical Occurrences
Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

Probability of Future Occurrences
Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

H.2.18 Conclusions on Hazard Risk

The hazard profiles presented above were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and

experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

Hazard Extent

Table H.32 describes the extent of each natural hazard identified for Raleigh. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE H.32 EXTENT OF RALEIGH HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page H:4). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Raleigh has received this ranking three times over the fourteen year reporting period.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Raleigh was 1.75 inches. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), Raleigh is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Thunderstorm Wind/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Raleigh was reported at 69 knots (approximately 79 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). The greatest magnitude reported was an F0 (reported on in March of 1993 and 1998).
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Raleigh. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is between low and moderate in Raleigh. There is also moderate susceptibility in some areas.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). Of the 98 dams in Raleigh, 57 are classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records located in Raleigh.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 7.8 percent of the total land area in Raleigh. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second.
Other Hazards	
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incidents reported in Raleigh are 75 LGA released on the highway in Raleigh and 40,000 SLB released via rail in Raleigh. It should be noted that larger events are possible.
Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).

Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

Priority Risk Index Results

In order to draw some meaningful planning conclusions on hazard risk for Raleigh, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). More information on the PRI and how it was calculated can be found in Section 5.20.2.

Table H.33 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups and Coordinating Committee. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE H.33: SUMMARY OF PRI RESULTS FOR RALEIGH

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	**2.5**
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	**2.4**
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	**2.5**
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	**2.1**
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	**3.1**
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.7**
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	**2.5**
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2**
Landslide	Possible	Minor	Small	Less than 6 hours	Less than 6 hours	**1.8**
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	**1.8**
Flood	Likely	Critical	Moderate	6 to 12 hours	Less than 1 week	**3**
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	**2**
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	**2.6**
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	**2.4**

H.2.16 Final Determinations on Hazard Risk

The conclusions drawn from the hazard profiling process for Raleigh, including the PRI results and input from the Regional Work Groups and Coordinating Committee, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table H.34**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Raleigh. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment* and below in Section H.3. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE H.34: CONCLUSIONS ON HAZARD RISK FOR RALEIGH

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Nuclear Accident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

H.3 CITY OF RALEIGH VULNERABILITY ASSESSMENT

This subsection identifies and quantifies the vulnerability of Raleigh to the significant hazards previously identified. This includes identifying and characterizing an inventory of assets in the county and assessing the potential impact and expected amount of damages caused to these assets by each identified hazard event. More information on the methodology and data sources used to conduct this assessment can be found in Section 6: *Vulnerability Assessment*.

H.3.1 Asset Inventory

Table H.35 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for Raleigh (study area of vulnerability assessment).[17]

TABLE H.35: IMPROVED PROPERTY IN RALEIGH

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Raleigh	121,927	$49,135,744,779	165,007	$33,719,903,927

Table H.36 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in Raleigh. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. In addition, a list of secondary facilities was created to recognize the importance of these facilities in the event of a disaster. These facilities were not mapped, but it is important to recognize that they could be potentially impacted by nearly any of the identified hazards, especially those that are atmospheric or have no specific spatial delineation.

All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure H.10** shows the locations of the primary critical facilities in Wake County. **Table H.48**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility. As noted previously, this list is not all-inclusive and only includes information provided by the local government.

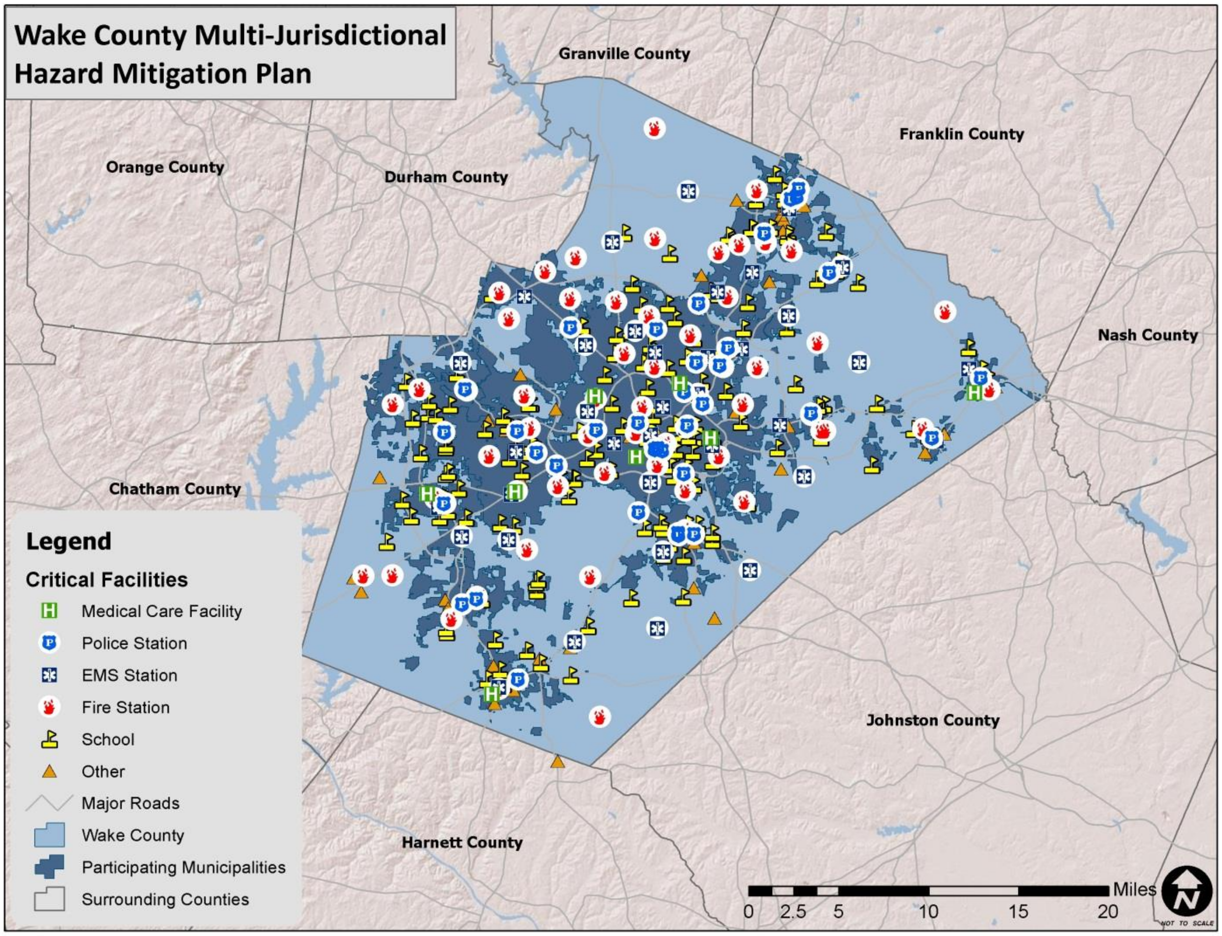
TABLE H.36: CRITICAL FACILITY INVENTORY IN RALEIGH

Location	Fire Stations	Police Stations	EMS Stations	Medical Care Facilities	Schools	Other
Raleigh	31	16	15	4	63	4

Source: Local Governments

[17] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

FIGURE H.10: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: Local Governments

H.3.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Raleigh that are potentially at risk to these hazards.

Table H.37 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, limited the results to county-wide estimates. The total population in Raleigh according to Census data is 403,892 persons. Additional population estimates are presented above in Section H.1.

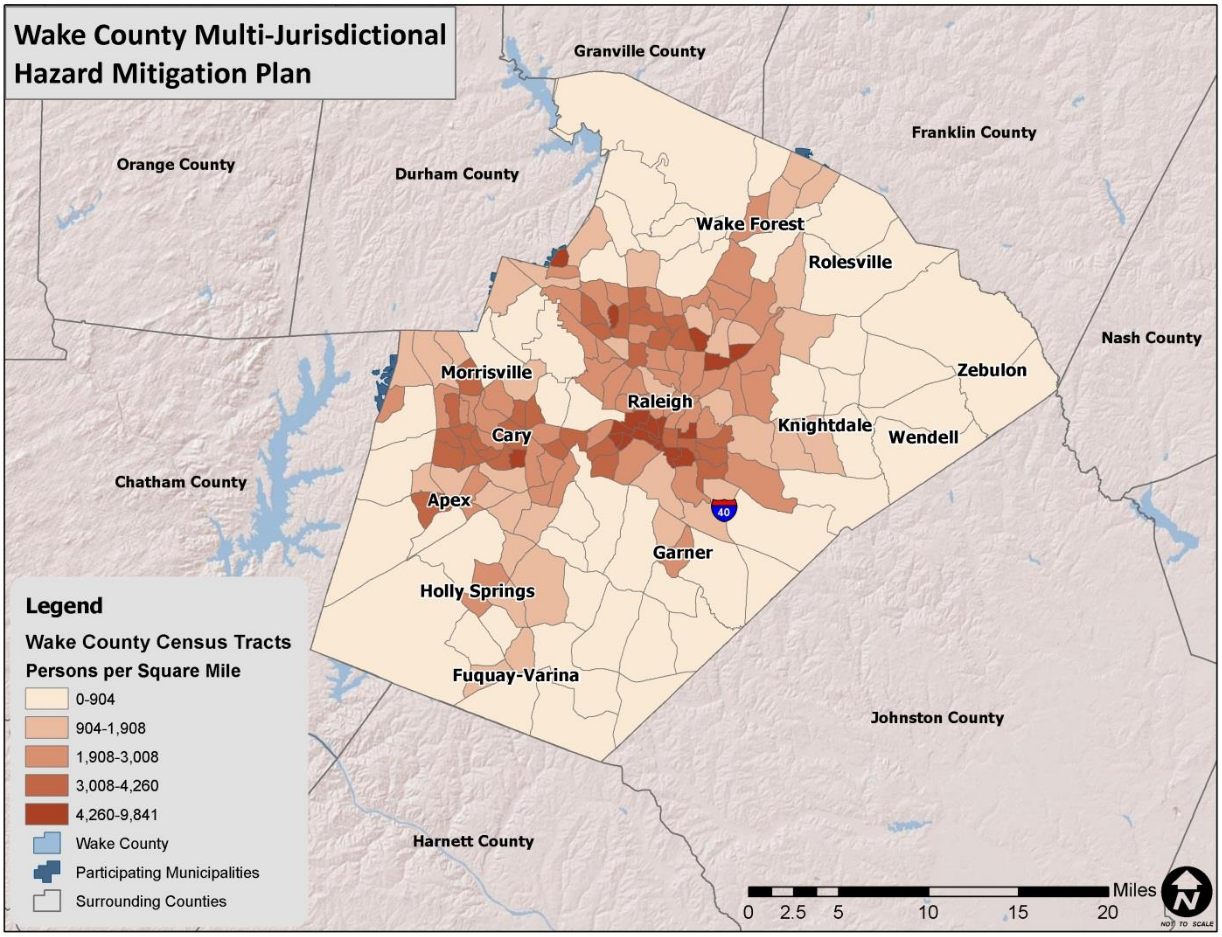
TABLE H.37: TOTAL POPULATION IN RALEIGH

Location	Total 2010 Population
Raleigh	403,892

Source: U.S. Census 2010

In addition, **Figure H.11** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[18]

FIGURE H.11: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

H.3.3 Vulnerability Assessment Results

As noted in Section 6: *Vulnerability Assessment*, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results, specific to Raleigh, are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total county exposure, and thus risk, was presented in **Table H.35**.

The annualized loss estimate for all hazards is presented at the end of this section in **Table H.47.**

The hazards presented in this section include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

18 Population by census block was not available at the time this plan was completed.

Hurricane and Tropical Storm

Historical evidence indicates that Raleigh has a significant risk to the hurricane and tropical storm hazard. Several tracks have come near or traversed through the county, as shown and discussed in Section H.2.4.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes, and high winds and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table H.38.** Only losses to buildings are reported, in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE H.38: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table H.39.**

TABLE H.39: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Raleigh	75.8	85.1	103.1	109.8

Source: Hazus-MH 2.1

Social Vulnerability

Given equal susceptibility across the county, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Raleigh, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table H.48** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Raleigh. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

Earthquake

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table H.40** summarizes the findings.

TABLE H.40: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability

It can be assumed that all existing future populations are at risk to the earthquake hazard.

Critical Facilities

The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table H.48**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Raleigh. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

Landslide

In order to complete the vulnerability assessment for landslides in Raleigh, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section H.2.10), tax parcel and building footprint data, and GIS analysis. **Table H.41** presents the potential at-risk property where available. All areas of Raleigh are identified as low or moderate incidence areas by the USGS landslide data. Some areas are also of moderate landslide susceptibility. Since there were no high incidence levels in the county, the moderate incidence level was used to identify different areas of concern for the analysis below.

TABLE H. 41: TOTAL POTENTIAL AT-RISK PARCELS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	**Moderate**		
Raleigh	4,995	6,645	$1,998,001,868

Source: USGS

Social Vulnerability

Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides. However, Raleigh is probably at somewhat higher risk than other jurisdictions.

Critical Facilities

All critical facilities are located in a moderate susceptibility area. This includes 1 fire station and 1 school. A list of specific critical facilities and their associated risk can be found in **Table H.48** at the end of this section.

In conclusion, a landslide has the potential to impact existing and future buildings, facilities, and populations in Raleigh, though some areas are at a higher risk than others due to a variety of factors. For example, steep slopes and modified slopes bear a greater risk than flat areas. Specific vulnerabilities for county assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

Flood

Historical evidence indicates that Raleigh is susceptible to flood events. A total of 36 flood events have been reported by the National Climatic Data Center resulting in $10,416,787 in damages. On an annualized level, these damages amounted to $5787,710 for Raleigh.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for the county. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table H.42** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

TABLE H.42: ESTIMATED EXPOSURE OF PARCELS TO THE FLOOD HAZARD

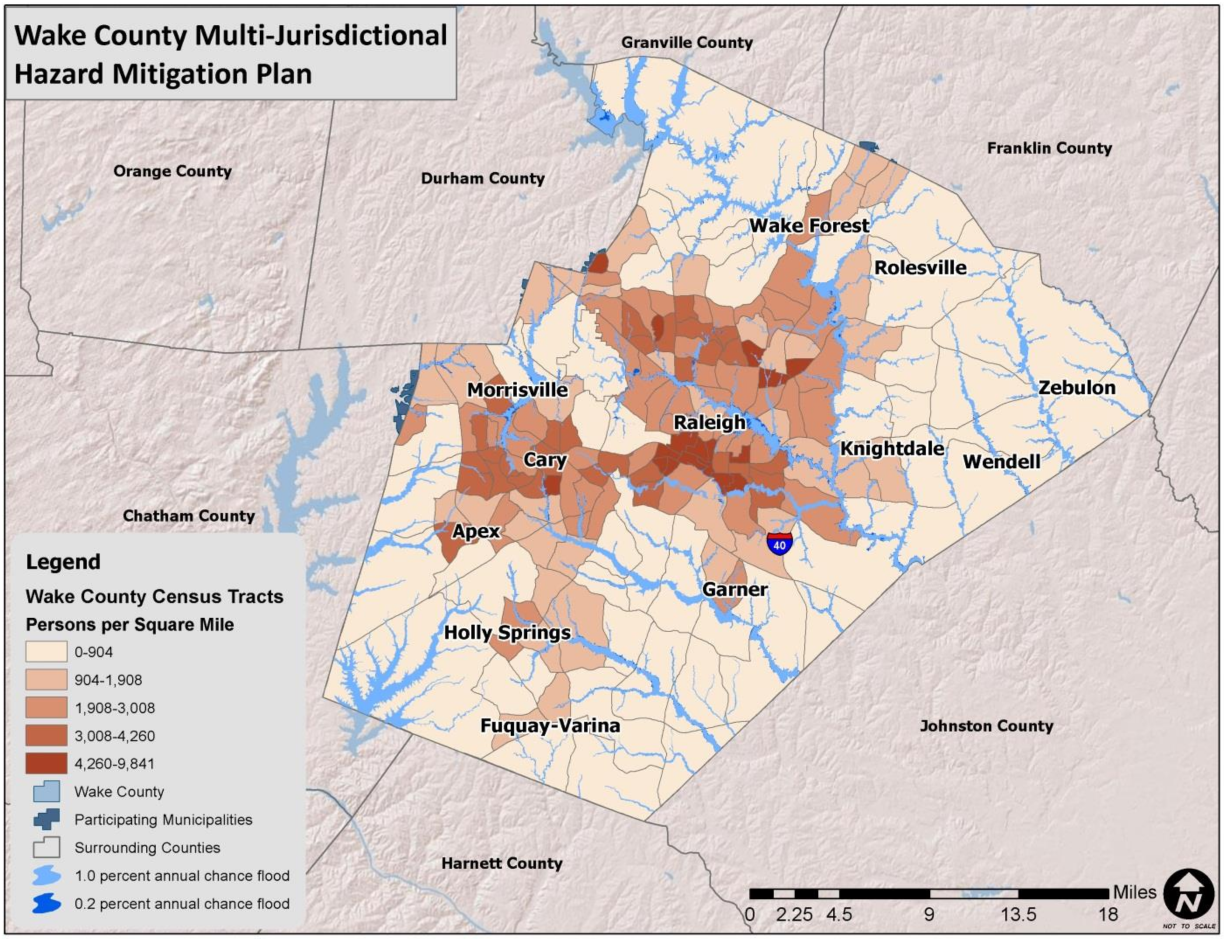
Location	1.0-percent ACF			0.2-percent ACF		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings
Raleigh	4,290	2,080	$3,539,297,338	1,018	924	$329,892,256

Source: FEMA DFIRM

Social Vulnerability

Since 2010 population was available at the tract level, it was difficult to determine a reliable figure on population at-risk to flood due to tract level population data. **Figure H.12** is presented to gain a better understanding of at risk population.

FIGURE H.12 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities

The critical facility analysis revealed that there is one critical facility located in the Raleigh 1.0-percent annual chance floodplain and 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. It is a fire station. A list of specific critical facilities and their associated risk can be found in **Table H.48** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings and populations in Raleigh, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

Hazardous Materials Incident

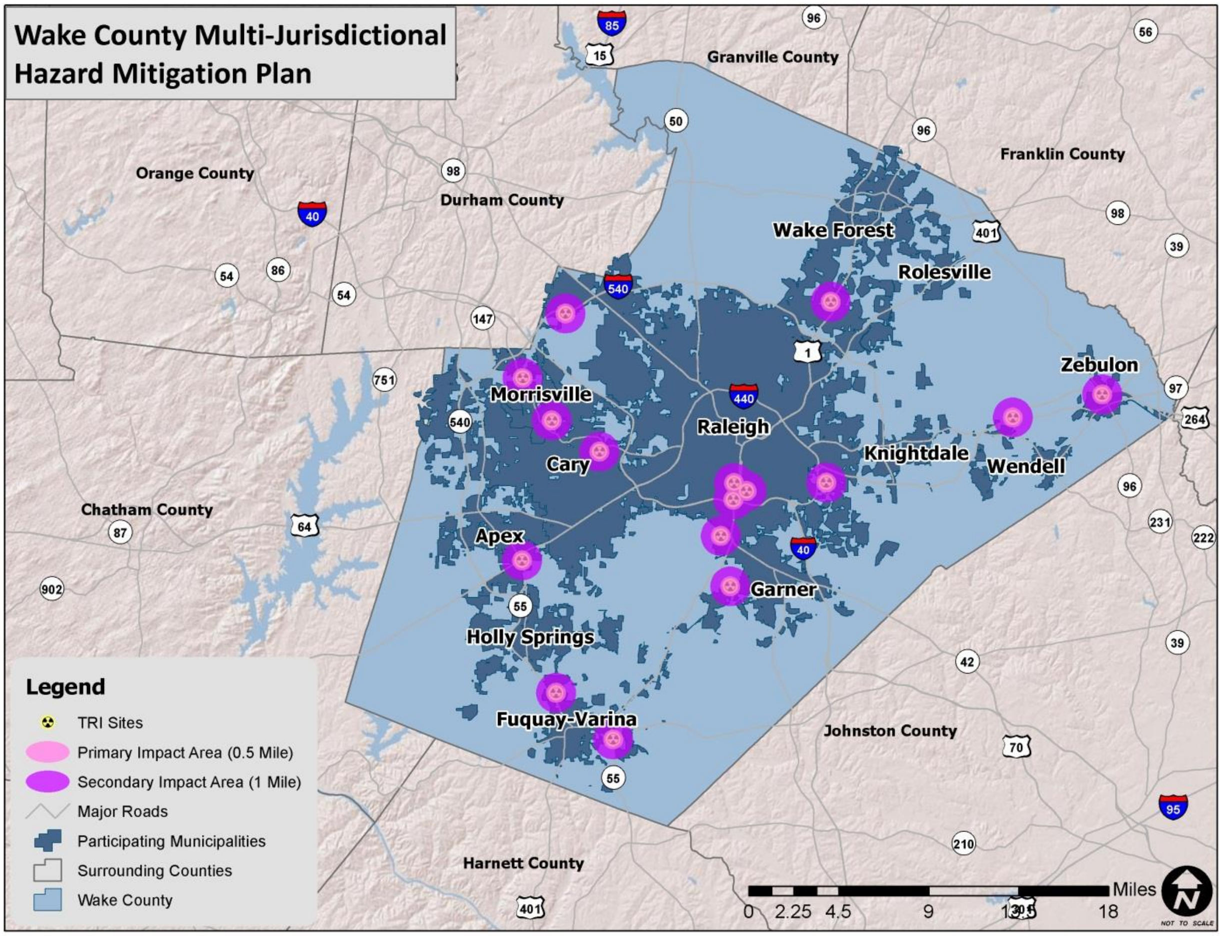
Although historical evidence and existing Toxic Release Inventory sites indicate that Raleigh is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Raleigh.

Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[19] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Raleigh, along with buffers, were used for analysis as shown in **Figure H.13.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the GIS buffer analysis. **Figure H.14** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table H.43** (fixed sites), **Table H.44** (mobile road sites) and **Table H.45** (mobile railroad sites).[20]

[19] This type of analysis will likely yield inflated results (generally higher than what is actually reported after an event).
[20] Note that parcels included in the 1.0-mile analysis are also included in the 0.5-mile analysis.

FIGURE H.13 : TRI SITES WITH BUFFERS IN RALEIGH



Source: EPA

TABLE H.43: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Raleigh	2,649	2,765	$955,126,130	9,522	9,576	$3,971,361,436

FIGURE H.14 : MOBILE HAZMAT BUFFERS IN RALEIGH

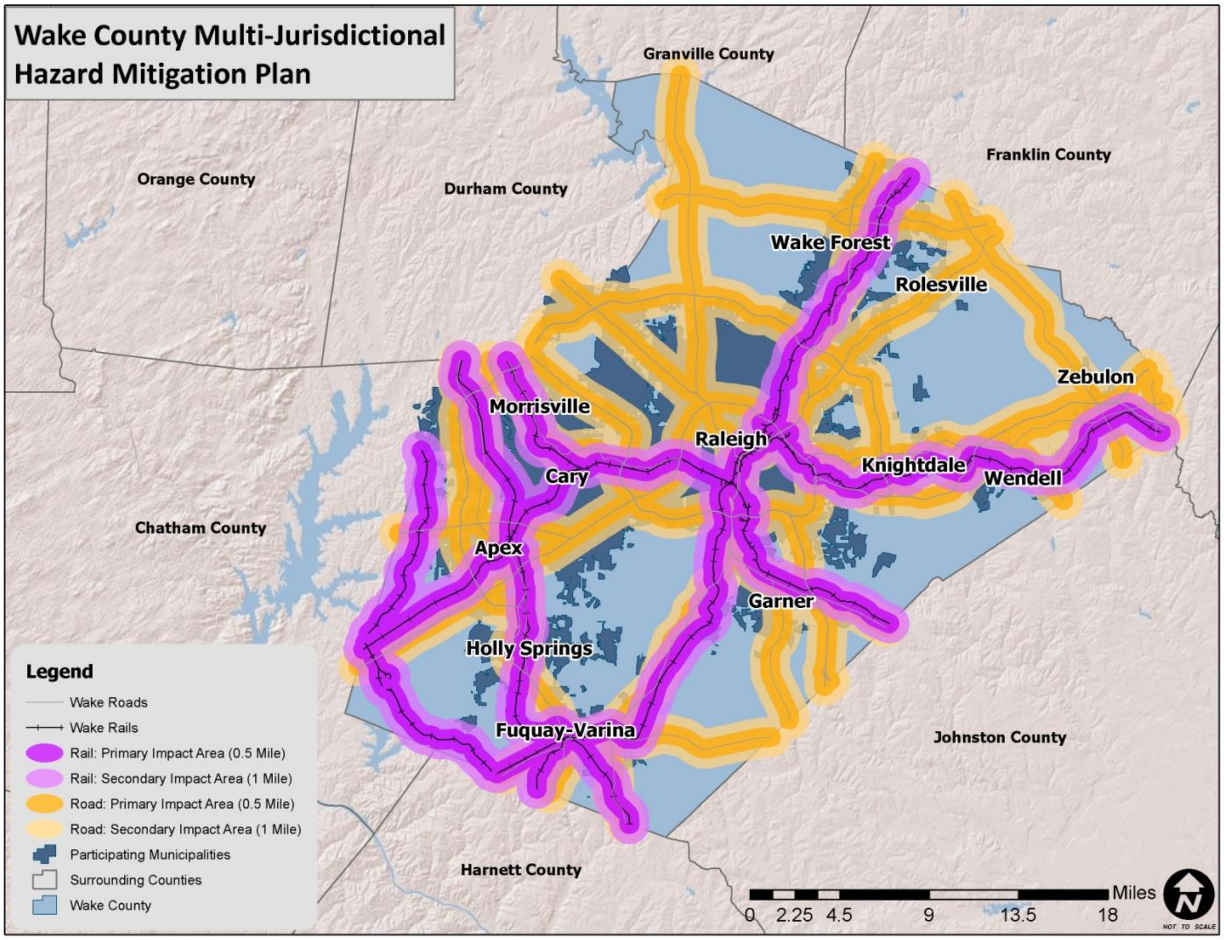


TABLE H.44: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Raleigh	51,224	66,676	$18,326,797,532	91,952	121,100	$27,821,957,624

TABLE H.45: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Raleigh	18,660	25,563	$8,902,424,404	38,922	53,598	$13,836,287,651

Social Vulnerability
Given high susceptibility across the jurisdiction, it is assumed that the total population is at risk to a hazardous materials incident. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities
Fixed Site Analysis:
The critical facility analysis for fixed TRI sites revealed that 20 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes just 3 facilities. The remaining facilities are in the secondary, 1.0-mile zone. A list of specific critical facilities and their associated risk can be found in **Table H.48** at the end of this section.

Mobile Analysis:
The critical facility analysis for road and railroad transportation corridors in Raleigh revealed that there are 104 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 61 facilities. The remaining facilities are in the secondary, 1.0-mile zone. The railroad buffer areas include 58 facilities with 38 in the primary impact zone. It should be noted that many of the facilities located in the buffer areas for railroad are also located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table H.48** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Raleigh. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc. Further, incidents from neighboring jurisdictions could also have an impact.

Wildfire
Although historical evidence indicates that Raleigh is susceptible to wildfire events, there are few reports of damage. Upon conversion of the wildfire risk data (see Section 6: *Vulnerability Assessment*) and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the jurisdiction should be assumed to be very low. As such, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the county.

Social Vulnerability
All areas have relatively equal vulnerability and there is low susceptibility across the entire county.
It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities
The critical facility analysis revealed that there are no critical facilities located in wildfire areas of concern. It should be noted, however, that several factors could impact the spread of a wildfire putting all facilities at risk. A list of specific critical facilities and their associated risk can be found in **Table H.48** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Raleigh.

Nuclear Accident

The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table H.46** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE H.46: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50 mile-buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[21]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[22]
Raleigh	0	0	$0	121,927	165,007	$33,719,903,927

Social Vulnerability

Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in the 10-mile nuclear buffer area in Raleigh.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in Raleigh, though areas closer to the power plant are at a higher risk than others. All structures are at some risk given that they are all located within at least the 50-mile buffer area.

Conclusions on Hazard Vulnerability

Table H.47 presents a summary of annualized loss for each hazard in Raleigh. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, although an annualized loss was determined through the damage reported through historical occurrences at the municipal level, it is likely that the county-wide

[21] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.

[22] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

estimate (found in Section 6: *Vulnerability Assessment*) is potentially a better estimate. These values should be used as an additional planning tool or measure risk for determining hazard mitigation strategies.

TABLE H.47: ANNUALIZED LOSS FOR RALEIGH*

Event	Raleigh
Dam Failure	Negligible
Drought	Negligible
Erosion	Negligible
Extreme Heat	Negligible
Hail	Negligible
Hurricane & Tropical Storm	Negligible
Landslide	Negligible
Lightning	$35,285
Thunderstorm Wind/High Wind[23]	$8,673
Tornado	$1,197
Winter Storm & Freeze	Negligible
Flood	$578,710
Earthquake	Negligible
HAZMAT Incident	Negligible
Wildfire	Negligible
Nuclear Accident	Negligible
Terror Threat	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table H.48** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

[23] The annualized losses for these hazards were combined.

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TABLE H.48: AT-RISK CRITICAL FACILITIES IN RALEIGH

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
RALEIGH																								
NORTH HILLS	EMS STATION	X	X	X	X	X	X	X	X	X													X	X
WHITAKER MILL	EMS STATION	X	X	X	X	X	X	X	X	X								X	X	X			X	X
FAIRGROUNDS	EMS STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
KNIGHTDALE SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
SIX FORKS MAIN	EMS STATION	X	X	X	X	X	X	X	X	X								X					X	X
MINICITY	EMS STATION	X	X	X	X	X	X	X	X	X								X	X	X			X	X
E RALEIGH	EMS STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
DOWNTOWN	EMS STATION	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
DURANT	EMS STATION	X	X	X	X	X	X	X	X	X										X			X	X
WAKE CROSSROADS	EMS STATION	X	X	X	X	X	X	X	X	X								X					X	X
HIGHWOODS	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
ST AUGUSTINES	EMS STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
GLENWOOD SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
CARALEIGH	EMS STATION	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
PLEASANT VALLEY	EMS STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RFD #23	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
RFD #17	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RFD #14	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
WESTERN WAKE #1	FIRE STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
RFD #8	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
RFD #20	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RFD #2	FIRE STATION	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
RFD #10	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
RFD #3	FIRE STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
RFD #5	FIRE STATION	X	X	X	X	X	X	X	X	X									X	X			X	X
RFD #6	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RFD #7	FIRE STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
RFD #12	FIRE	X	X	X	X	X	X	X	X	X						X	X	X					X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
	STATION																							
RFD #18	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
BAY LEAF #3	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
RFD #9	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RFD #4	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
RFD #11	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE-NEW HOPE #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RFD #19	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
RFD #15	FIRE STATION	X	X	X	X	X	X	X	X	X										X			X	X
RFD #16	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RFD #1	FIRE STATION	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
RFD #21	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
RFD #22	FIRE STATION	X	X	X	X	X	X	X	X	X						X		X	X	X			X	X
RFD #24	FIRE STATION	X	X	X	X	X	X	X	X	X		X				X	X	X					X	X
RFD #25	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
RFD #27	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
RFD #26	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
RFD #28	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
KEETER TRAINING CENTER- FIRE	FIRE STATION	X	X	X	X	X	X	X	X	X			X		X	X	X	X	X	X			X	X
DORTHEA DIX	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X						X		X	X	X			X	X
RCMB- WAKEMED	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X								X		X			X	X
REX	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X								X					X	X
DUKE RALEIGH	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
PULSTAR REACTOR AT NCSU	OTHER	X	X	X	X	X	X	X	X	X									X	X			X	X
EMJ WWTP	OTHER	X	X	X	X	X	X	X	X	X													X	X
PUBLIC WORKS	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
MUNICIPAL BUILDING- ECC	OTHER	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
NORTHEAST DISTRICT	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
DETECTIVE DIVISION	POLICE STATION	X	X	X	X	X	X	X	X	X									X	X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
SOUTHEAST DISTRICT	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
SOUTHWEST DISTRICT	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
RALEIGH (MAIN)	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
DOWNTOWN DISTRICT	POLICE STATION	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X			X	X
NORTHWEST DISTRICT	POLICE STATION	X	X	X	X	X	X	X	X	X						X	X	X					X	X
MAIN STATION INTERIM	POLICE STATION	X	X	X	X	X	X	X	X	X													X	X
NORTH DISTRICT	POLICE STATION	X	X	X	X	X	X	X	X	X													X	X
CRITICAL PUBLIC SAFETY BUILDING	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
POLICE DISTRICT STATION- INTERACT	POLICE STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
POLICE DISTRICT STATION- NE OUTREACH	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
POLICE DISTRICT STATION- NEIGHBORHOOD STATION	POLICE STATION	X	X	X	X	X	X	X	X	X								X		X			X	X
POLICE DISTRICT STATION- MOUNTED POLICE	POLICE STATION	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
POLICE DISTRICT STATION- SERVICE, SPECIAL OPS	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
POLICE TRAINING CENTER	POLICE STATION	X	X	X	X	X	X	X	X	X								X					X	X
COMBS ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
ATHENS DRIVE HS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
BROUGHTON HS	SCHOOL	X	X	X	X	X	X	X	X	X								X	X	X			X	X
POWELL ES	SCHOOL	X	X	X	X	X	X	X	X	X								X		X			X	X
MARY E PHILLIPS HS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
LIGON MS	SCHOOL	X	X	X	X	X	X	X	X	X						X		X		X			X	X
WASHINGTON ES	SCHOOL	X	X	X	X	X	X	X	X	X					X	X	X	X	X	X			X	X
CARNAGE MS	SCHOOL	X	X	X	X	X	X	X	X	X						X		X	X	X			X	X
DANIELS MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
ROOT ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
LYNN ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
BROOKS ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
CARROLL MS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
DOUGLAS ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
MILLBROOK ES	SCHOOL	X	X	X	X	X	X	X	X	X									X	X			X	X
WILBURN ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
EAST MILLBROOK MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
FOX ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
LEAD MINE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
BUGG ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
DURANT ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X										X			X	X
STOUGH ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
YORK ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
JEFFREYS GROVE ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
SOUTHEAST RALEIGH HS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
ROCK QUARRY SERVICE CENTER	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
BRENTWOOD ES	SCHOOL	X	X	X	X	X	X	X	X	X								X		X			X	X
ENLOE HS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
MILLBROOK HS	SCHOOL	X	X	X	X	X	X	X	X	X									X	X			X	X
NORTH RIDGE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
SANDERSON HS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
WEST MILLBROOK MS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
MARTIN MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
OLDS ES	SCHOOL	X	X	X	X	X	X	X	X	X									X	X			X	X
WILEY ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WILDWOOD FOREST ES	SCHOOL	X	X	X	X	X	X	X	X	X						X	X	X		X			X	X
PARTNERSHIP ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
CENTENNIAL CAMPUS MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
MOORE SQUARE MS	SCHOOL	X	X	X	X	X	X	X	X	X						X	X	X		X			X	X
BAILEYWICK ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
BRIER CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X		X				X	X	X					X	X
DURANT ROAD MS	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
HILBURN DRIVE ACADEMY	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
CONN ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
UNDERWOOD ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
MT VERNON SCHOOL	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKEFIELD ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
WAKEFIELD MS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
WAKEFIELD HS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
GREEN ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
HARRIS CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
DILLARD DRIVE MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
DILLARD DRIVE ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
SPRING FOREST ROAD MODULAR	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
NORTH FOREST PINES ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
RIVER OAKS MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X		X			X	X
BARWELL ROAD ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
FOREST PINES DRIVE ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
FULLER ES	SCHOOL	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
HUNTER ES	SCHOOL	X	X	X	X	X	X	X	X	X										X			X	X
POE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
LONGVIEW SCHOOL	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
WAKE EARLY COLLEGE OF HEALTH AND SCIENCES	SCHOOL	X	X	X	X	X	X	X	X	X								X	X	X			X	X

Secondary Critical Facilities are listed in slight contrast to Critical Facilities as their continued function has not been deemed as critical as primary facilities in the event of a disaster, but these facilities are extremely important. A loss of function to one of these facilities would have a definitively greater negative impact on the community's ability to respond to and recover from a disaster than a loss of function at other facilities/structures within the jurisdiction. In **Table H.49**, these facilities have been classified as either Significant Community Locations/Sheltering Centers or as Critical Resources Management Facilities. These facilities are all vulnerable to any of the atmospheric hazards and many are also likely vulnerable to other hazards identified above, though no locational analysis was carried out to this end.

TABLE H.49: RALEIGH SECONDARY CRITICAL FACILITIES

Facility Name	Address*	Type
Raleigh		
Dillon Building	W. Martin	Significant Community Location or Sheltering Center
Anderson Pointe	Anderson Point Dr	Significant Community Location or Sheltering Center
Apollo Heights	Lunar Dr	Significant Community Location or Sheltering Center
Barwell Rd. Park	Barwell Rd.	Significant Community Location or Sheltering Center
Biltmore Hills community Center	Fitzgerald Dr	Significant Community Location or Sheltering Center
Brentwood Park	Vinson Place	Significant Community Location or Sheltering Center
Bufflaloe Rd Park	Buffaloe Rd	Significant Community Location or Sheltering Center
Carolina Pines Community Center	Lake Wheeler Rd	Significant Community Location or Sheltering Center
Chavis	Holmes St	Significant Community Location or Sheltering Center
Downtown Remote operation - F&O	Brentwood Rd	Significant Community Location or Sheltering Center
Durant Campbell Lodge	Durant Rd	Significant Community Location or Sheltering Center
Eastgate	Quail Hollow Dr	Significant Community Location or Sheltering Center
Fayetteville St Mall	Fayetteville St Mall	Significant Community Location or Sheltering Center
Fletcher Borden Building	Clay St.	Significant Community Location or Sheltering Center
Fletcher Park Garris Building	Clay St.	Significant Community Location or Sheltering Center
Glen Eden	Glen Eden Dr	Significant Community Location or Sheltering Center
Green Rd	Green Rd	Significant Community Location or Sheltering Center
Greystone Recreation Center	Leadmine Rd	Significant Community Location or Sheltering Center
Halifax Park	Halifax St	Significant Community Location or Sheltering Center
Horseshoe Farm old house	Horse Shoe Farm Rd	Significant Community Location or Sheltering Center
Jaycee Community Center	Wade Ave	Significant Community Location or Sheltering Center
John P Top Greene Community Ctr	Martin Luther King Jr Blvd	Significant Community Location or Sheltering Center
Kiwanis Park	Noble Rd	Significant Community Location or Sheltering Center
Lake Johnson - Waterfront, Concession, Bathhouse	Avent Ferry Rd	Significant Community Location or Sheltering Center
Lake Lynn Community Center	Ray Rd	Significant Community Location or Sheltering Center
Lake Wheeler Waterfront Center	Lake Wheeler Rd	Significant Community Location or Sheltering Center
Laurel Hills Community Center	Edward Mills Rd	Significant Community Location or Sheltering Center

Facility Name	Address*	Type
Lions Community Center	Dennis Ave	Significant Community Location or Sheltering Center
Marsh Creek Maintenance Facility Admin	Daly Rd	Significant Community Location or Sheltering Center
Marsh Creek Maintenance Facility Head House	Daly Rd	Significant Community Location or Sheltering Center
Marsh Creek Park Community Center	New Hope Rd	Significant Community Location or Sheltering Center
Method Community Center	Method Rd	Significant Community Location or Sheltering Center
Millbrook Community Center	Spring Forest Rd	Significant Community Location or Sheltering Center
Andrew Johnson Birthplace	Mimosa St	Significant Community Location or Sheltering Center
Mordecai House	Mimosa St	Significant Community Location or Sheltering Center
One Exchange Plaza	Fayetteville St	Significant Community Location or Sheltering Center
Optimist Community Center	Whittier Dr	Significant Community Location or Sheltering Center
Peach Rd Neighborhood Center	Peach Rd	Significant Community Location or Sheltering Center
Police Department Cabarrus	W Cabarrus St	Significant Community Location or Sheltering Center
Powell Dr	Powell Dr	Significant Community Location or Sheltering Center
Service Garage - VFS	New Bern Ave	Critical Resources Management (Energy, Water, etc.)
Bus Garage - Radio shop	S Blount St	Critical Resources Management (Energy, Water, etc.)
H.E. Repair Fac - VFS	New Bern Ave	Critical Resources Management (Energy, Water, etc.)
Public Works Tech Shop	S Wilmington St	Critical Resources Management (Energy, Water, etc.)
Butler Bldg- Public Works	S Wilmington St	Critical Resources Management (Energy, Water, etc.)
Peace St- Public Works	W. Peace St., 9	Critical Resources Management (Energy, Water, etc.)
Salt Storage	Dortch St.	Critical Resources Management (Energy, Water, etc.)
Vehicle Fleet Services	N. West St., 4120 New Bern Ave.	Critical Resources Management (Energy, Water, etc.)
Heavy Equipment Facility- Public Works	new Bern Ave	Critical Resources Management (Energy, Water, etc.)
Pullen Park Community Center	Ashe Ave	Significant Community Location or Sheltering Center
Theatre in the Park	Pullen Rd	Significant Community Location or Sheltering Center
Raleigh Little Theatre	Pogue St	Significant Community Location or Sheltering Center
Roberts Community Ctr	E Martin St	Significant Community Location or Sheltering Center
Sanderford Neighborhood Center	Sanderford Rd	Significant Community Location or Sheltering Center
Southgate Neighborhood Center	Proctor Rd	Significant Community Location or Sheltering Center
Shelly / Sertoma Arts Center	West Millbrook Rd	Significant Community Location or Sheltering Center
Solid Waste Services Scale House	Corporate Prkwy	Critical Resources Management (Energy, Water, etc.)
Solid Waste Services Scale House	N New Hope Rd	Critical Resources Management (Energy, Water, etc.)
Solid Waste Services Yard Waste	New Hope Rd	Critical Resources Management (Energy, Water, etc.)
Solid Waste Services Transfer Station	Corporate Prkwy	Critical Resources Management (Energy, Water, etc.)
Tarboro Rd Community Center	Tarboro Rd	Significant Community Location or Sheltering Center
Tucker House	North Person St	Significant Community Location or Sheltering Center
Walnut Creek Wetland Community Ctr	Peterson St	Significant Community Location or Sheltering Center
Adminstration Bldg - Wilder's Grove – Remote	Beacon Lake Dr	Significant Community Location or Sheltering Center

Facility Name	Address*	Type
Operations Center		
Worthdale Community Center	Cooper Rd	Significant Community Location or Sheltering Center
Brier Creek Community Ctr	Globe Rd	Significant Community Location or Sheltering Center
Raleigh Convention Center	500 S Salisbury St	Significant Community Location or Sheltering Center
Red Hat Ampitheater	500 S McDowell St	Significant Community Location or Sheltering Center

**Some address information could not be provided or was not applicable to the facility*

H.4 CITY OF RALEIGH CAPABILITY ASSESSMENT

This subsection discusses the capability of the City of Raleigh to implement hazard mitigation activities. More information on the purpose and methodology used to conduct the assessment can be found in Section 7: *Capability Assessment*.

H.4.1 Planning and Regulatory Capability

Table H.50 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the City of Raleigh. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE H.50: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning Tool/Regulatory Tool	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan (Parks & Rec/Greenway Plan	Stormwater Management Plan/Ordinance	Natural Resource Protection Plan	Flood Response Plan	Emergency Operations Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	National Flood Insurance Program (NFIP)	NFIP Community Rating System
Raleigh	✓	✓		✓	✓			✓				✓	✓		✓	✓	✓	✓		✓	✓	✓	✓

A more detailed discussion on the city's planning and regulatory capabilities follows.

Emergency Management

Hazard Mitigation Plan
The City of Raleigh has previously adopted a hazard mitigation plan.

Emergency Operations Plan
The City of Raleigh has adopted the Wake County Emergency Operations Plan. The city also maintains a municipal-level emergency operations plan.

General Planning

Comprehensive Land Use Plan
The City of Raleigh has adopted the *2030 Comprehensive Plan*.

Capital Improvements Plan
The City of Raleigh has a 10-year capital improvement plan in place.

Zoning Ordinance
The City of Raleigh includes zoning regulations as part of the local unified development ordinance.

Subdivision Ordinance
The City of Raleigh also includes subdivision regulations as part of the local unified development ordinance.

Building Codes, Permitting, and Inspections
North Carolina has a state compulsory building code which applies throughout the state. The building code is enforced within the city's planning jurisdiction by the City of Raleigh Inspections Department.

Floodplain Management

Table H.51 provides NFIP policy and claim information for the City of Raleigh.

TABLE H.51: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
Raleigh	08/15/78	04/16/07	1,988	$513,805,200	725	$18,503,795

Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Community Rating System
The City of Raleigh participates in the CRS and is a Class 7 community.

Flood Damage Prevention Ordinance
All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. The City of Raleigh participates in the NFIP and has adopted flood damage prevention regulations.

Open Space Management Plan
The City of Raleigh has adopted the *Capital Area Greenway Master Plan* as well as the *Neuse River Regional Park Master Plan*.

Stormwater Management Plan
The City of Raleigh has not adopted a stormwater management plan; however, the city includes stormwater management regulations as part of the local unified development ordinance.

H.4.2 Administrative and Technical Capability

Table H.52 provides a summary of the capability assessment results for the City of Raleigh with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in the town with the specified knowledge or skill.

TABLE H.52: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	Planners with knowledge of land development/land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency Manager	Floodplain Manager	Land Surveyors	Scientists familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Resource development staff or grant writers
Raleigh	✓	✓	✓	✓	✓		✓	✓	✓	

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

H.4.3 Fiscal Capability

Table H.53 provides a summary of the results for the City of Raleigh with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plan.

TABLE H.53: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes (or taxing districts)	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.
Raleigh	✓	✓	✓					✓	✓	✓

H.4.4 Political Capability

The previous hazard mitigation plan indicates that the City of Raleigh has already instituted a number of measures that support community efforts to protect the health, safety, and welfare of the public before and during a natural disaster. The Raleigh City Council has shown and will continue to show support for hazard mitigation efforts that reduce future loss of life and property to the effects of natural hazards. While acknowledging the realistic resources both monetarily and physically at the city's disposal, the Raleigh City Council will continue to enforce and explore ways to enhance regulations that not only limit development in the flood hazard areas but also work to reduce stormwater runoff that contributes to flooding. The citizens, property owners, business owners, and elected officials and staff of the City of Raleigh are fully aware of the potential for hazard threats to life and property. The city views the development and adoption of a hazard mitigation plan as another means to achieve the goal of a safer community in which to live, work, and play.

H.4.5 Conclusions on Local Capability

Table H.54 shows the results of the capability assessment using the designed scoring methodology described in Section 7: *Capability Assessment*. The capability score is based solely on the information found in existing hazard mitigation plan and readily available on the city's government website. According to the assessment, the local capability score for the city is 46, which falls into the high capability ranking.

TABLE H.54: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
Raleigh	46	High

H.5 CITY OF RALEIGH MITIGATION STRATEGY

This subsection provides the blueprint for Raleigh to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Regional Work Groups and the findings and conclusions of the capability assessment and risk assessment. Additional Information can be found in Section 8: *Mitigation Strategy* and Section 9: *Mitigation Action Plan*.

H.5.1 Mitigation Goals

Raleigh developed seven mitigation goals in coordination with Wake County and the other participating jurisdictions. The county-wide mitigation goals are presented in **Table H.55**.

TABLE H.55: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

H.5.2 Mitigation Action Plan

The mitigation actions proposed by Raleigh are listed in the following Mitigation Action Plan.

City of Raleigh Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Include annual capital budget for the City for ongoing program of stormwater infrastructure improvements. $23.6 million over 10 years.	Flood	Moderate	Raleigh Public Works	Local	Completed	This item has been completed. The fiscal year 2013-14 stormwater capital improvement plan includes $70,000,000 over 10 years for stormwater infrastructure improvements. This action will be removed from the next update.
P-2	Establish a Lake Preservation Policy that encourages private property owners to preserve existing lakes and ponds, and in certain circumstances provides for public assistance.	Flood	Moderate	Raleigh Public Works	Local	2016	Four lake projects are currently under design and construction is projected to be complete on most of these by 2016. While these projects involve water quality benefits, most of these projects involve dam and spillway upgrades (to a higher design storm frequency) that provide additional protection to downstream areas and to avoid dam failures.
P-3	Develop ongoing multi-year program of detailed basin studies for each watershed in City's jurisdiction. Fifteen basin studies are complete with 10 additional studies budgeted in the capital program. (CRS 410).	Flood	Moderate	Raleigh Public Works	Local	2016	We have broken down the city into three main basins. One basin (Walnut Creek) has been completed with the other two being completed by 2016.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-4	Planning Commission to consider program to develop future conditions floodplain mapping for all FEMA mapped areas (this is already done for non-FEMA mapped areas). The program would consist of a multi-year capital program for mapping for all FEMA streams in the ETJ and consideration of changes to development regulations in these areas. Future conditions would be based on expected development per the Comprehensive Plan and zoning maps.	Flood	Moderate	Raleigh Public Works	Local	2014	Maps have been approved, State will be going public with the maps.
Property Protection							
PP-1	Develop ongoing program designed to utilize Federal grant resources to assist private property owners in relocating existing structures out of flood hazard zones. (CRS 500/510/520)	Flood	Moderate	Raleigh Public Works	Local Federal	2019	The city has been approved for multiple grants and removed these structures from the floodplain. The city will continue to try to secure funding for these types of projects in the future.
PP-2	Develop an ongoing program designed to utilize Federal grant resources to assist private property owners in elevating existing structures located within flood hazard zones. (CRS 510/530)	Flood	Moderate	Raleigh Public Works	Local Federal	2019	The City has applied for grants, but has been unsuccessful in obtaining grant assistance for these type projects. The City also has reserved dollars from the stormwater utility fund to supplement potential grant funding and this funding in the Capital Improvement Program is estimated to average approximately $250,000 per year. The city will continue to try to secure funding for these types of projects in the future.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PP-3	Develop an ongoing program designed to utilize Federal grant resources to assist private property owners in renovating and retrofitting existing structures in flood hazard zones to reduce vulnerability to flooding damage.	Flood	Moderate	Raleigh Public Works	Local Federal	2019	The City has applied for grants, but has been unsuccessful in obtaining grant assistance for these type projects. The City also has reserved dollars from the stormwater utility fund to supplement potential grant funding and this funding in the Capital Improvement Program is estimated to average approximately $250,000 per year. The city will continue to try to secure funding for these types of projects in the future.
PP-4	Continue sewer easement clearing and aerial main inspection/cleaning to prevent and eliminate obstructions and erosion that can lead to infrastructure failure, as required by NCDWQ regulations.	Flood	High	Raleigh Public Works	Local	Completed	Easements are regularly inspected and mowed. The aerial mains are inspected quarterly. This action will be removed in the next update as a capability.
PP-5	Require dedication of floodplain property for greenways upon development of property for residential purposes. (CRS 420)	Flood	Moderate	Raleigh Parks and Recreation	Local	Completed	The city requires dedication of floodplain property for greenways upon development of residential property. This action will be removed in the next update as a capability.
PP-6	Revise Comprehensive Plan to consider expanding greenway corridor widths and additional environmental protections for floodplains. (CRS 420)	Flood	Moderate	Raleigh Parks and Recreation, Public Works, and DCP	Local	Completed	The Comprehensive Plan has been revised to expand greenway corridors and added environmental protections for floodplains. This action will be removed in the next update as a capability.
PP-7	Neuse River Master Plan calls for the use of easements, donor gifts, grants, inter-local agreements, public/private partnerships, wetlands mitigation funds, and leases to protect corridor along the entire Neuse River. (CRS 420)	Flood	Moderate	Raleigh Parks and Recreation	Local	Completed	$1 million in 5-year CIP to develop Horseshoe Farm Park. This action will be removed in the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PP-8	When the City's -initiated annexation areas extra-territorial jurisdiction is expanded, or when areas outside the extra-territorial jurisdiction are annexed into the City, initially zone all 100-year floodplain areas to Conservation Buffer zoning district, which restricts development to very limited uses. (CRS 430LZ)	Flood	Moderate	Raleigh Planning	Local	Completed	This policy is active and in place so this action will be removed in the next update as a capability.
Natural Resource Protection							
NRP-1	Develop local program to enforce Erosion and Sedimentation Control standards. Local sedimentation control program complements state program. Eleven staff positions dedicated to this program.	Flood	High	Raleigh Public Works	Local State	Completed	The sedimentation program has been assessed over the last two years and has resulted in improvements in the inspections process, consistency of inspections, plan reviews, and coordination between plan reviewers and inspectors. This action will be removed in the next update as a capability.
Structural Projects							
SP-1	Management and repair of reservoirs, retention and detention basins	Flood	High	Raleigh Public Works	Local	Completed	Program to implement repairs and replacement of stormwater infrastructure in parks, roadways and other public property has been implemented. This action will be removed from the next update as a capability.
Emergency Services							
ES-1	Provide and enhance technical rescue capabilities more equitably throughout the City.	All	High	Raleigh Fire	Local	2018	Technical rescue capabilities have been enhanced more equitably throughout the city, but the city would like to continue to improve this by expanding resources, so this will be pursued going forward.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-2	Provide after-action report of emergency response to severe weather events in order to improve planning for future disasters.	All	High	Raleigh Fire and Emergency Management	Local	Post Event	The city completes after action reports as soon as possible post-event. This action will be removed in the next update.
ES-3	Maintain a standard operating guideline to direct operational planning prior to anticipated weather emergencies.	All	High	Raleigh Fire and Emergency Management	Local	2015, Annual review and update	The city maintains an SOG that is put into place prior to weather emergencies. This SOG is reviewed and updated annually, so this action will remain in the plan going forward.
ES-4	Design GIS programming capable of providing real-time data to emergency managers and historic data for future emergency response planning.	All	High	Raleigh City Manager and Information Technology	Local	2019	A GIS program that can provide real-time data has been developed, but there is still a great deal of work to be done on the system to make it more useful, so the city will continue to try to advance the system.
ES-5	Provide urban search and rescue services consisting of structural collapse and similar emergencies.	All	High	Raleigh Fire	Local State	Completed	USAR services consist of response to structural collapse and similar emergencies. Training occurs at least annually. This action will be removed from the next update as a capability.
ES-6	Continue Walnut Creek and Swift Creek dam warning systems from Lakes Johnson, Raleigh, Wheeler and Benson to the Neuse River. (CRS 610/630)	Flood	High	Raleigh Public Utilities	Local	Completed	The warning systems for Lakes Benson, Wheeler, Johnson and Raleigh are in service. This action will be removed from the next update as a capability.
ES-7	Deploy semi-tractor with Low-Boy Conex trailers for transportation of emergency barricades and other equipment on a large scale.	All	Moderate	Raleigh Police	Local	Deleted	Delete Conex trailers…these are large storage trailers.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-8	Continued use and testing of USGS automated flood warning system and automated reporting on creeks and rivers, e.g., Crabtree Creek. (CRS 610)	All	High	United States Geological Survey	Federal	Completed	Upon notification of rising creeks and possible flooding, units are sent to check visually every 30 minutes for level readings. Note the USGS stream gage data is now available at 15 minute intervals during floods via telephone or the internet. Stormwater staff routinely provides the Command Center staff this information. USGS tests the system every 6 weeks. If schools become threatened, Wake County School Security implements written evacuation plan. This action will be removed from the next update as a capability.
ES-9	ECC Notifications BY NOAA for possible severe weather (tornados, ice, etc.).	All	High	National Oceanic and Atmospheric Administration	Federal State	Completed	ECC is notified by both agencies when weather alerts are issued. Information then broadcast over police radios. This action will be removed from the next update as a capability.
ES-10	ACU 1000 Communications Unit – Currently being tested. System should allow all agencies on ACU 1000 to communicate using own radios and frequencies.	ALL	Moderate High	Raleigh Police	Local	Completed	First responders now utilize the 800 mhz system and can communicate State-Wide with agencies utilizing that system. The ACU 1000 is also operational and can be used for agencies not on the 800 system. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-11	Develop Water Emergency Response Plan in accordance with EPA mandate with wastewater emergency plan developed voluntarily.	All	High	Raleigh Public Utilities	Local (EPA grant)	Completed	This item was completed in 2003 and updated in 2005. The plans are regularly updated. This action will be removed from the next update as a capability.
ES-12	Continue to conduct disaster tabletop exercise program.	All	Low	Raleigh Public Utilities, Fire, Police, City Manager, Emergency Management, and Public Works	Local	2015, Annual review and update	Tabletop disaster exercises are held regularly and will need to be updated and evaluated to ensure applicability to appropriate hazards. The city will conduct and review exercises on at least an annual basis.
ES-13	Program to install emergency electrical generators at all public utilities facilities. Current focus on redundant generators at critical facilities, second fuel truck and completion of 100% generator coverage in Garner area.	All	High	Raleigh Public Utilities	Local	2017	Emergency electrical generators have been installed at public utilities facilities including wastewater pump stations, water booster pump stations, water treatment plants, and the wastewater treatment plants, except for the pump stations in Wake Forest. Installation of emergency generators at the pump stations in Wake Forest is under way as part of the merger capital improvements plan. Redundant electrical generators have been installed at the critical facilities including the NRWWTP influent pump station, NRWWTP UV disinfection facility, and the Walnut Creek Lift Station

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-14	Critical Security Post Coverage - Certain fixed sites identified for coverage during disasters - water treatment, municipal complex, wastewater treatment, etc.	All	Low	Raleigh Police	Local	Completed	Vulnerable business and offices have been identified and are contacted in the event of rising waters. Duplicate of ES-14, so action is complete and will be removed from next update.
ES-15	Mobile Command Post equipped to communicate with all agencies in the Triangle including Emergency Management, State agencies, fire departments, etc.	All	Moderate	Raleigh Police	Local	Completed	Mobile Command Post is available 24 hours a day and is equipped to communicate with all agencies in the Triangle including Emergency Management, State agencies, fire departments, etc. This action will be removed from the next update as a capability.
ES-16	Develop drought preparedness and response program that includes conservation regulations, enforcement programs, and preliminary arrangements for alternate sources of water supply.	Drought	Moderate	Raleigh Public Utilities	Local	Completed	Water conservation plan and drought response plan are in place. Retention of existing water (swimming pools, newly developed cistern system, and non-potable water containment system) This action will be removed from the next update as a capability.
ES-17	Develop Emergency Response plans for buildings	All	Low	Raleigh Police	Local	Completed	Emergency Response plans are all designed for officers to be assigned for security purposes until owners can take over the responsibility of securing premises. Progress made. Personnel will cover critical locations to the best of our ability. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-18	Participate extensively in NC water and sewer utilities mutual aid provision and system development.	All	Moderate	Raleigh Public Utilities	Local FEMA	Completed	The PUD helped develop and is a member of the NCWARN program (NC Water and wastewater Agency Response Network) with other utilities statewide to provide mutual aid to each other. This action will be removed from the next update as a capability.
ES-19	Counseling	All	Low	Raleigh Police	Local	Completed	Police psychologist and a Critical Incident Stress Debriefing Team training to provide debriefing sessions for personnel. This action will be removed from the next update as a capability.
Public Education and Awareness							
PEA-1	Provide technical assistance to private property owners who are subject to structural flooding.	Flood	Moderate	Raleigh Public Works	Local	Completed	Conservation engineer does site inspection and reports recommendation to reduce flood damage. This action will be removed from the next update as a capability.
PEA-2	Provide flood zone information to any inquirer.	Flood	High	Raleigh Public Works	Local	Completed	Stormwater staff provides flood zone information through call-in or e-mail program to any inquirer. City requires showing flood zone information on all plats recorded in City's jurisdiction. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-3	Environmental Education	Flood	Moderate	Raleigh Public Works	Local	Completed	City maintains a stormwater web site to answer citizen questions about flood hazards, flood safety, availability of flood insurance, and various programs, operates a speakers' bureau and published a 24-page stormwater utility program brochure in 2004. (CRS 330) A Stormwater Public Education position was approved in the 08-09 budget that specifically addresses education needs in the stormwater area. This action will be removed from the next update as a capability.
PEA-4	Develop WaterFest Outreach Program (CRS 360)	All	Low	Raleigh Public Utilities	Local	Completed	Annual event draws up to 6,000 school children, plus teachers and chaperones. Focus on environmental issues, including sewer, stormwater, solid waste management, etc. in late spring. City continues to conduct this event. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-5	Partner with Wake County to utilize the "Communicator" application that will warn property owners of impending flood events. (CRS 610)	Flood	Moderate	Raleigh Information Services and Information Technology	Local	Completed	The City partners with Wake County to utilize the "Communicator" application that utilizes GIS technology to develop automated call lists to warn property owners of impending flood events. (CRS 610) The communicator application is now available for city use. This action will be removed from the next update as a capability.
PEA-6	Institute "Stormwater hotline" (CRS 360)	Flood	Moderate	Raleigh Public Works	Local	Completed	City maintains a stormwater hotline which is answered extended hours during the week. Citizens may report flooding problems, pollution issues, erosion problems, infrastructure damage. City continues to maintain the hotline. This action will be removed from the next update as a capability.
PEA-7	When available, the City will incorporate and use new LIDAR flood maps. Information will be available to the public. (CRS 320/440)	Flood	Moderate	Raleigh Public Works	Local	Completed	New maps have been adopted as the updated FEMA flood insurance rate map. This action will be removed from the next update as a capability.
PEA-8	City will continue to maintain flood elevation certificates and make copies available to the public. (CRS 310/440)	Flood	Moderate	Raleigh Inspections	Local	Completed	City continues to maintain certificates and make copies available to public. This action will be removed from the next update as a capability.
PEA-9	City will continue to update flood hazard maps to reflect new subdivisions, changes in corporate limits, and any new DFIRM data. (CRS 320/440)	Flood	Moderate	Raleigh Public Works, Inspections, and Planning	Local	Completed	City continues to update the maps. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-10	The city will leverage the State of NC Residential Property Disclosure Statement which includes check off on whether or not the property being offered for sale is within a Federally-designated floodplain. (CRS 340)	Flood	Moderate	State of North Carolina	State	Completed	City continues to include the check off for floodplains. This action will be removed from the next update as a capability.
PEA-11	The City will support Wake County efforts to make flood protection educational materials available in all branches of the Wake County public library system. (CRS 350).	Flood	Moderate	Wake County	County	Completed	City continues to supply local libraries with educational information. This action will be removed from the next update as a capability.

Annex I
Town of Rolesville

This annex includes jurisdiction-specific information for the Town of Rolesville. It consists of the following five subsections:

- I.1 Town of Rolesville Community Profile
- I.2 Town of Rolesville Risk Assessment
- I.3 Town of Rolesville Vulnerability Assessment
- I.4 Town of Rolesville Capability Assessment
- I.5 Town of Rolesville Mitigation Strategy

I.1 TOWN OF ROLESVILLE COMMUNITY PROFILE

I.1.1 Geography and the Environment

Rolesville is town located in Wake County in the state of North Carolina. It has become one of the three fastest growing communities in North Carolina over the past 10 years.

Overall, Wake County is known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Summer temperatures generally venture into the 90s for highs and cool off to the 70s at night. Winter temperatures in can drop to below freezing but generally highs are in the 50s. Rainfall is most common in the summer months but occurs consistently throughout the year.

I.1.2 Population and Demographics

According to the 2010 Census, Rolesville has a population of 3,786 people. The jurisdiction has seen exceptional growth between 2000 and 2010, and the population density is almost 1,000 people per square mile. Population counts from the US Census Bureau for 1990, 2000, and 2010 are presented in **Table I.1**.

TABLE I.1: POPULATION COUNTS FOR ROLESVILLE

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
ROLESVILLE	572	907	3,786	317.42%

Source: US Census Bureau

The racial characteristics of the jurisdiction are presented in **Table I.2**. Whites make up the majority of the population in the jurisdiction, accounting for nearly 75 percent of the population.

TABLE I.2: DEMOGRAPHICS OF ROLESVILLE

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
ROLESVILLE	74.1%	17.8%	0.4%	7.7%	6.1%

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

I.1.3 Housing

According to the 2010 US Census, there are 1,341 housing units in Rolesville, the majority of which are single family homes or mobile homes. Housing information for the jurisdiction is presented in **Table I.3**.

TABLE I.3: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Seasonal Units, Percent (2010)	Median Home Value (2006-2010)
ROLESVILLE	384	1,341	7.8%	$246,200

Source: US Census Bureau

I.1.4 Infrastructure

Transportation
There are several major roadways that residents of Rolesville utilize. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs, one of which is I-540/NC-540 which is a partly completed loop that connects the jurisdiction to many of the other municipalities. In addition to the Interstate, there are many major highways that residents of the municipality utilize. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways in the include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities
Electrical power in the jurisdiction is provided by two entities and Duke Energy and Wake Electric Membership Corporation with Duke Energy providing service to a majority of the service. Water and sewer service is provided by two main entities as well: The City of Raleigh Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

Community Facilities

There are a number of buildings and community facilities located throughout Rolesville. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 1 fire station, 1 police station, and 4 public schools located within the county.

Citizens also have access to several parks, including three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the county, including the American Tobacco Trail which is a rails to trails project that is open to a wide variety of non-motorized uses.

I.1.5 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land as parks. There are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the jurisdiction consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

I.1.6 Employment and Industry

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

I.2 TOWN OF ROLESVILLE RISK ASSESSMENT

This subsection includes hazard profiles for each of the significant hazards identified in Section 4: *Hazard Identification* as they pertain to Rolesville. Each hazard profile includes a description of the hazard's location and extent, notable historical occurrences, and the probability of future occurrences. Additional information can be found in Section 5: *Hazard Profiles*.

I.2.1 Drought

Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, Rolesville has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that the county would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Historical Occurrences

According to the North Carolina Drought Monitor, Rolesville has had drought occurrences all of the last fourteen years (2000-2013). **Table I.4** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE I.4: HISTORICAL DROUGHT OCCURRENCES IN ROLESVILLE

Abnormally Dry **Moderate Drought** **Severe Drought** **Extreme Drought** **Exceptional Drought**

	Rolesville
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that Rolesville has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

I.2.2 Extreme Heat

Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to any geographic or political boundaries. All of Rolesville is susceptible to extreme heat conditions.

Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Rolesville. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the region. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the county. The most centralized location is in Raleigh at North Carolina State University. **Table I.5** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table I.5: Average Maximum Temperature in Raleigh, Wake County

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

I.2.3 Hailstorm

Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Rolesville is uniformly exposed to severe thunderstorms; therefore, all areas are equally exposed to hail which may be produced by such storms.

Historical Occurrences

According to the National Climatic Data Center, 5 recorded hailstorm events have affected Rolesville since 1993.[1] **Table I.6** is a summary of the hail events in Rolesville. **Table I.7** provides detailed information about each event that occurred. In all, hail occurrences resulted in over $0 (2013 dollars) in property damages. Hail ranged in diameter from 0.88 inches to 1.75 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value.

Table I.6: Summary of Hail Occurrences in Rolesville

Location	Number of Occurrences	Property Damage (2013)
Rolesville	5	$0

Source: National Climatic Data Center

[1] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Rolesville. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

TABLE I.7: HISTORICAL HAIL OCCURRENCES IN ROLESVILLE

	Date	Magnitude	Deaths/Injuries	Property Damage*
Rolesville				
Rolesville	6/12/1995	1.5 in.	0/0	$0
ROLESVILLE	4/3/2006	1 in.	0/0	$0
ROLESVILLE	5/18/2006	1.75 in.	0/0	$0
ROLESVILLE	5/20/2006	0.88 in.	0/0	$0
ROLESVILLE	5/20/2008	1 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that Rolesville has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the county.

I.2.4 Hurricane and Tropical Storm

Location and Spatial Extent

Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Rolesville. The entire jurisdiction is equally susceptible to hurricane and tropical storms.

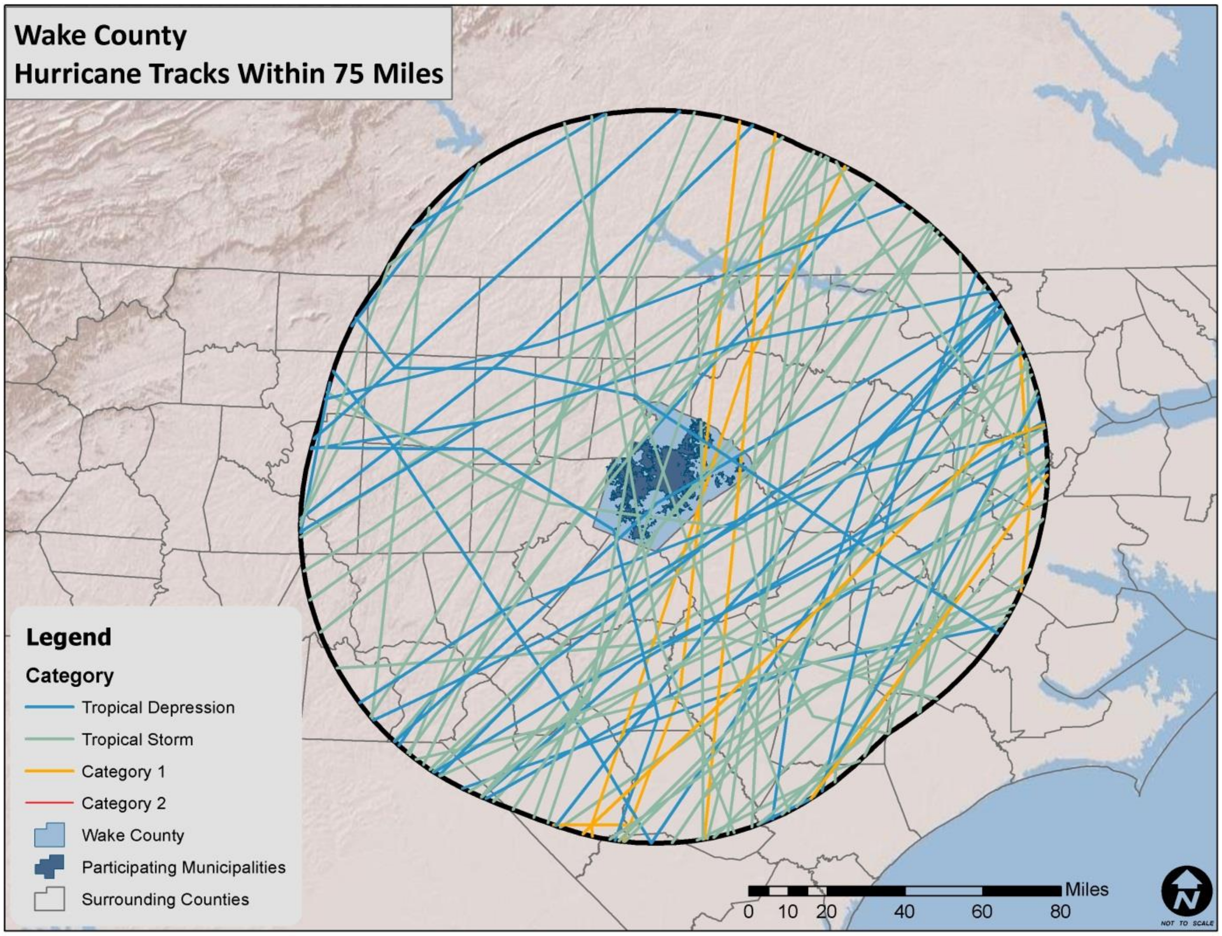
Historical Occurrences

According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[2] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms have traversed directly through Wake County as shown in **Figure I.1**. **Table I.8** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

[2] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

FIGURE I.1: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE I.8: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1
1882	NOT NAMED	53	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm
1959	CINDY	26	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression
2008	HANNA	40	Tropical Storm

Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Rolesville between 1950 and 2013. These storms are listed in **Table I.9** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE I.9: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made in 1996 (Hurricane Fran), 1999 (Hurricane Floyd), and 2003 (Hurricane Isabel) for the county.[3]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Tropical Storm Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

Probability of Future Occurrences
Given the inland location of the jurisdiction, it is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Rolesville. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the jurisdiction is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

[3] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

I.2.5 Lightning

Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Rolesville is uniformly exposed to lightning.

Historical Occurrences

According to the National Climatic Data Center, there have been no recorded lightning events in Rolesville since 1950, as listed in summary **Table I.10** and detailed in **Table I.11**.[4] However, it is certain that more lightning events have in fact impacted the jurisdiction. Many of the reported events are those that caused damage, and it should be expected that damages are likely much higher for this hazard than what is reported.

TABLE I.10: SUMMARY OF LIGHTNING OCCURRENCES IN ROLESVILLE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Rolesville	0	0/0	$0

Source: National Climatic Data Center

TABLE I.11: HISTORICAL LIGHTNING OCCURRENCES IN ROLESVILLE

	Date	Deaths/Injuries	Property Damage*	Details
Rolesville				
None reported				

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Although there were not a high number of historical lightning events reported in Rolesville via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S. National Lightning Detection Network (NLDN®), Rolesville is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the jurisdiction.

I.2.6 Severe Thunderstorm/High Wind

Location and Spatial Extent

A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Rolesville. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

favorable for generating these powerful storms. Also, Rolesville typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Rolesville has uniform exposure to an event and the spatial extent of an impact could be large.

Historical Occurrences

Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011.[5] According to NCDC, there have been 9 reported thunderstorm/high wind events since 1994 for high wind and since 1950 for thunderstorms.[6] These events caused over $0 (2013 dollars) in damages. **Table I.12** summarizes this information. **Table I.13** presents detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event.[7]

TABLE I. 12: SUMMARY OF THUNDERSTORM/HIGH WIND OCCURRENCES IN ROLESVILLE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Rolesville	9	0/0	$0

Source: National Climatic Data Center

TABLE I.13: HISTORICAL THUNDERSTORM/HIGH WIND OCCURRENCES IN ROLESVILLE

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Rolesville					
ROLESVILLE	5/1/1997	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	8/18/2000	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	11/11/2002	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	4/3/2006	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	5/14/2006	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	6/23/2006	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	7/27/2006	TSTM WIND	50 kts.	0/0	$0
ROLESVILLE	7/11/2007	THUNDERSTORM WIND	50 kts.	0/0	$0
ROLESVILLE	8/21/2011	THUNDERSTORM WIND	50 kts.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire jurisdiction.

[5] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional thunderstorm events have occurred in Rolesville. As additional local data becomes available, this hazard profile will be amended.
[7] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

I.2.7 Tornado

Location and Spatial Extent

Tornadoes occur throughout the state of North Carolina, and thus in Rolesville. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Rolesville is uniformly exposed to this hazard.

Historical Occurrences

Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there has been one recorded tornado event in Rolesville since 1956 (**Table I.14**), resulting in nearly $110,000 (2013 dollars) in property damages.[8] Detailed information on this event can be found in **Table I.15**. The magnitude of this tornado was a F0 in intensity, although an F5 event is possible. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is likely that a high number of occurrences have gone unreported over the past 50 years.

TABLE I.14: SUMMARY OF TORNADO OCCURRENCES IN ROLESVILLE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Rolesville	1	0/1	$109,273

Source: National Climatic Data Center

TABLE I.15: HISTORICAL TORNADO IMPACTS IN ROLESVILLE

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Rolesville					
ROLESVILLE	3/6/2011	F0	0/1	$109,273	EPISODE NARRATIVE: Convection developed along and ahead of a cold front that moved across the state during the late afternoon and early evening hours. Two weak EF0 tornadoes developed across central North Carolina when discrete cells along a couple of mesolows merged with the main convective band.

*Property Damage is reported in 2013 dollars.
Source: NCDC

2011 Tornadoes- April 16, 2011

In 2011, the county and all of its jurisdictions were impacted by one of the worst tornado-related events in the county's recorded history. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries.

[8] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Rolesville. As additional local data becomes available, this hazard profile will be amended.

Probability of Future Occurrences

According to historical information, tornado events are not an annual occurrence for the jurisdiction. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Rolesville experience a direct tornado strike. The probability of future tornado occurrences affecting Rolesville is likely (10-100 percent annual probability).

I.2.8 Winter Storm and Freeze

Location and Spatial Extent

Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Rolesville is accustomed to smaller scale severe winter weather conditions and often receives severe winter weather during the winter months. Given the atmospheric nature of the hazard, the entire jurisdiction has uniform exposure to a winter storm.

Historical Occurrences

Severe winter weather has resulted in six disaster declarations in Rolesville. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. [9] According to the National Climatic Data Center, there have been no recorded winter storm events in Rolesville since 1993 (**Table I.16**).[10] These events resulted in $0 (2013 dollars) in damages. However, there have been 28 recorded countywide events and most severe winter weather events are only recorded at the county level.

TABLE I.16: SUMMARY OF WINTER STORM EVENTS IN ROLESVILLE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Rolesville	0	0/0	$0

Source: National Climatic Data Center

There have been several severe winter weather events in Rolesville. The text below describes one of the major events and associated impacts on the county. Similar impacted can be expected with severe winter weather.

1996 Winter Storm

This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and

[9] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.

[10] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional winter storm conditions have affected Rolesville.

power outages. Furthermore, citizens may resort to using inappropriate heating devices that could to fire or an accumulation of toxic fumes.

Probability of Future Occurrences

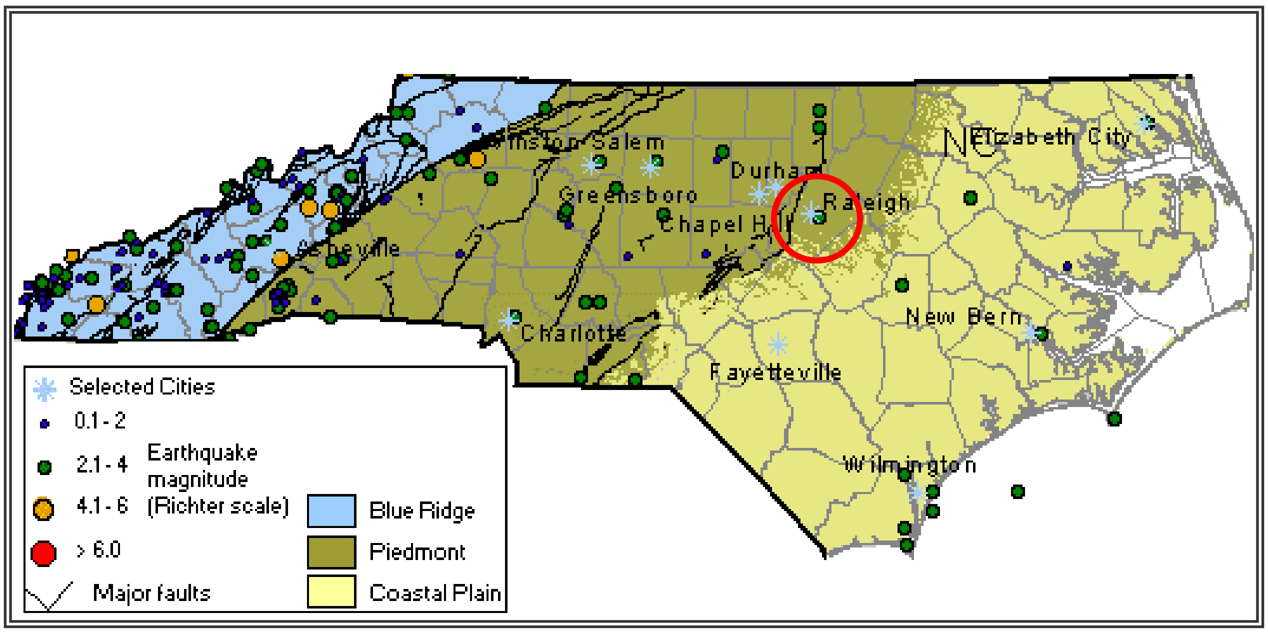
Winter storm events will remain a somewhat regular occurrence in Rolesville due to location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

I.2.9 Earthquake

Location and Spatial Extent

Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina. **Figure I.2** is a map showing geological and seismic information for North Carolina.

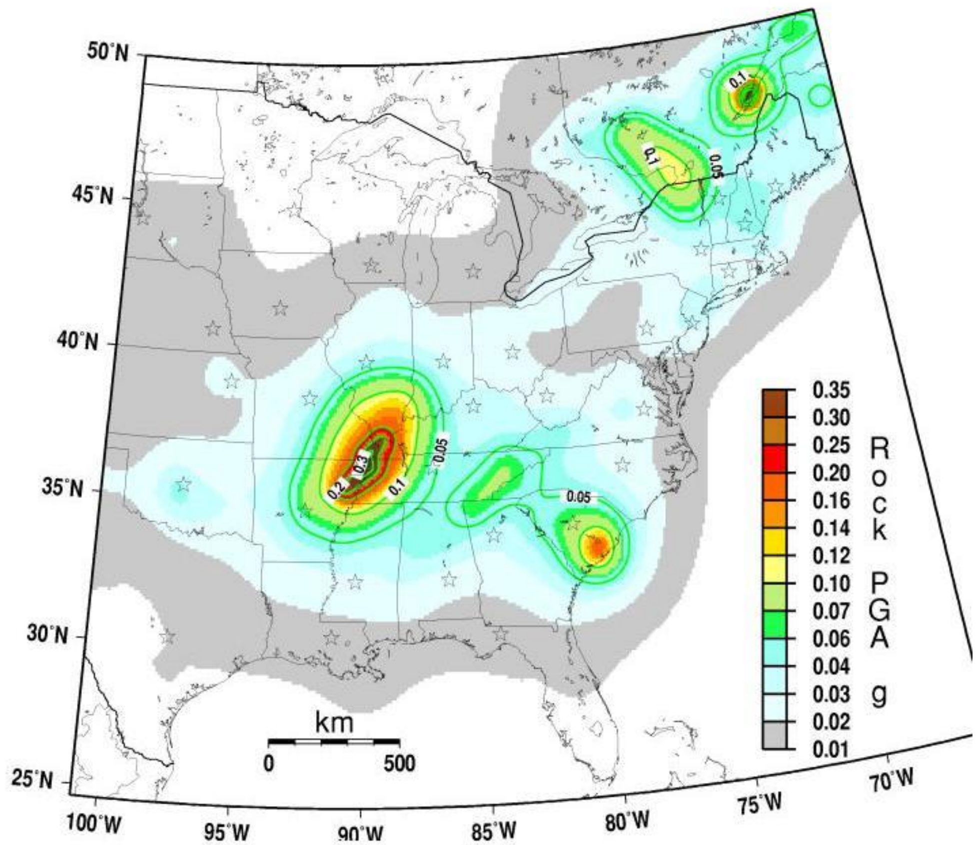
FIGURE I.2: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure I.3 shows the intensity level associated with Rolesville, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Rolesville lies within an approximate zone of level “2” to “3” ground acceleration. This indicates that the county exists within an area of moderate seismic risk.

FIGURE I.3: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

Historical Occurrences

Although no earthquakes are known to have occurred directly in Rolesville since 1874, several have occurred in the county and affected the municipality. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table I.17** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table I.18** presents a detailed occurrence of each event including the date, distance for the epicenter, and Modified Mercalli Intensity (if known). [11]

TABLE I.17: SUMMARY OF SEISMIC ACTIVITY IN ROLESVILLE

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Rolesville	--	--	--

Source: National Geophysical Data Center

[11] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

TABLE I.18: SIGNIFICANT SEISMIC EVENTS IN ROLESVILLE (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI (magnitude)
Rolesville				
None reported				

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Rolesville, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table I.19.**

TABLE I.19: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 - 1	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928*	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957*	Buncombe County, NC	3.7	VI	VI
11/24/1957*	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973*	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Rolesville occurrences.
** Conflicting reports on this event, intensity in North Carolina could have been either V or VI
Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Rolesville is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. The annual probability level for the county is estimated between 1 and 10 percent (possible).

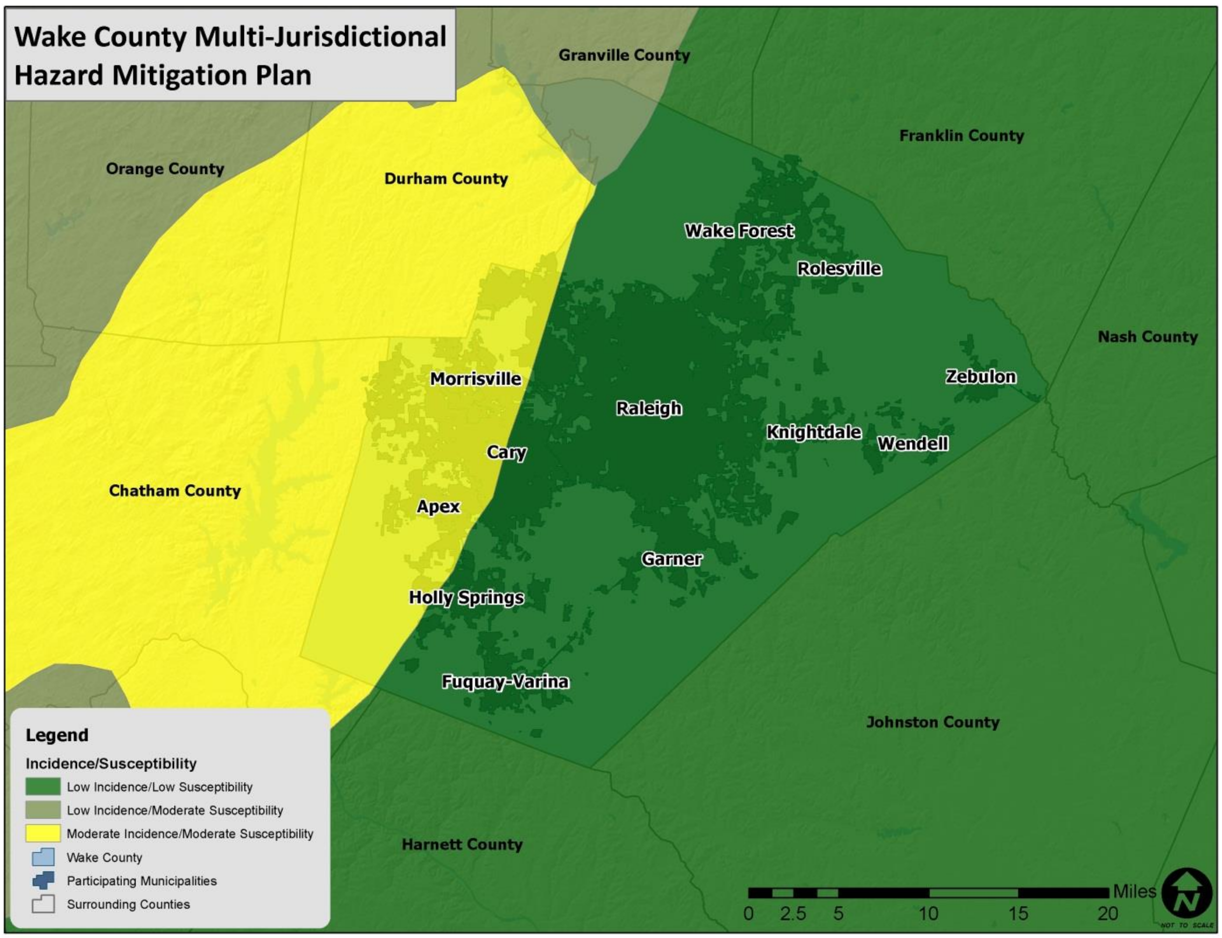
I.2.10 Landslide

Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Rolesville, although the overall risk is relatively low.

According to **Figure I.4** below, the majority of the county has low landslide activity. However there is a small area along the western border of the county that has a moderate incidence and moderate susceptibility. In all other areas (including all of Rolesville), there is low susceptibility.

FIGURE I.4: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

Historical Occurrences

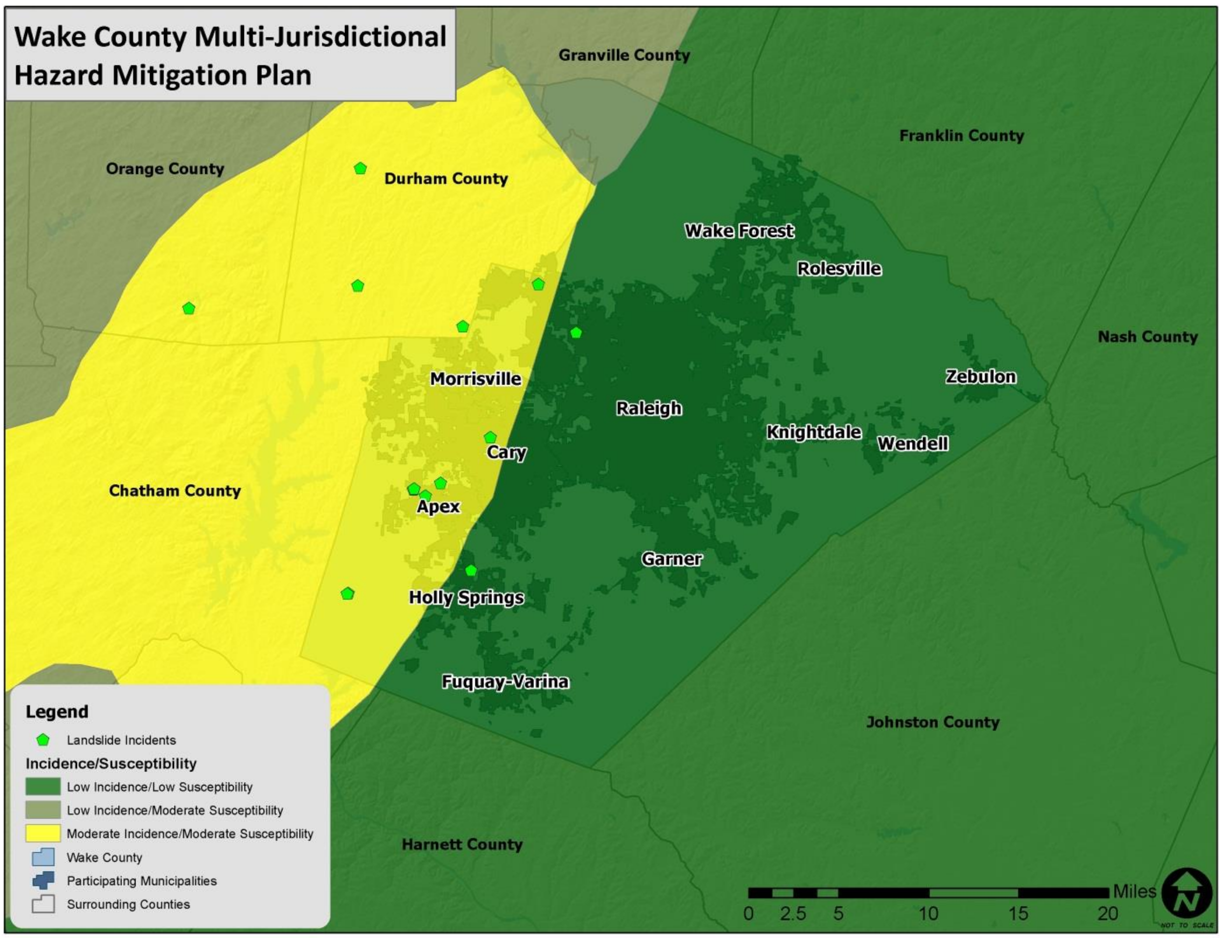
Steeper topography in some areas of Rolesville make the planning area susceptible to landslides. Most landslides are caused by heavy rainfall in the area. Building on steep slopes that was not previously possible also contributes to risk. **Table I.20** presents a summary of the landslide occurrence events as provided by the North Carolina Geological Survey[12]. The georeferenced locations of the landslide events presented in the aforementioned tables are presented in **Figure I.5**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred in Rolesville.

TABLE I.20: SUMMARY OF LANDSLIDE ACTIVITY IN ROLESVILLE

Location	Number of Occurrences
Rolesville	0

Source: North Carolina Geological Survey

FIGURE I.5: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for

[12] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Rolesville have greater risk than others given factors such as steepness on slope and modification of slopes.

I.2.11 Dam and Levee Failure

Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table I.21** explains these classifications.

TABLE I.21: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

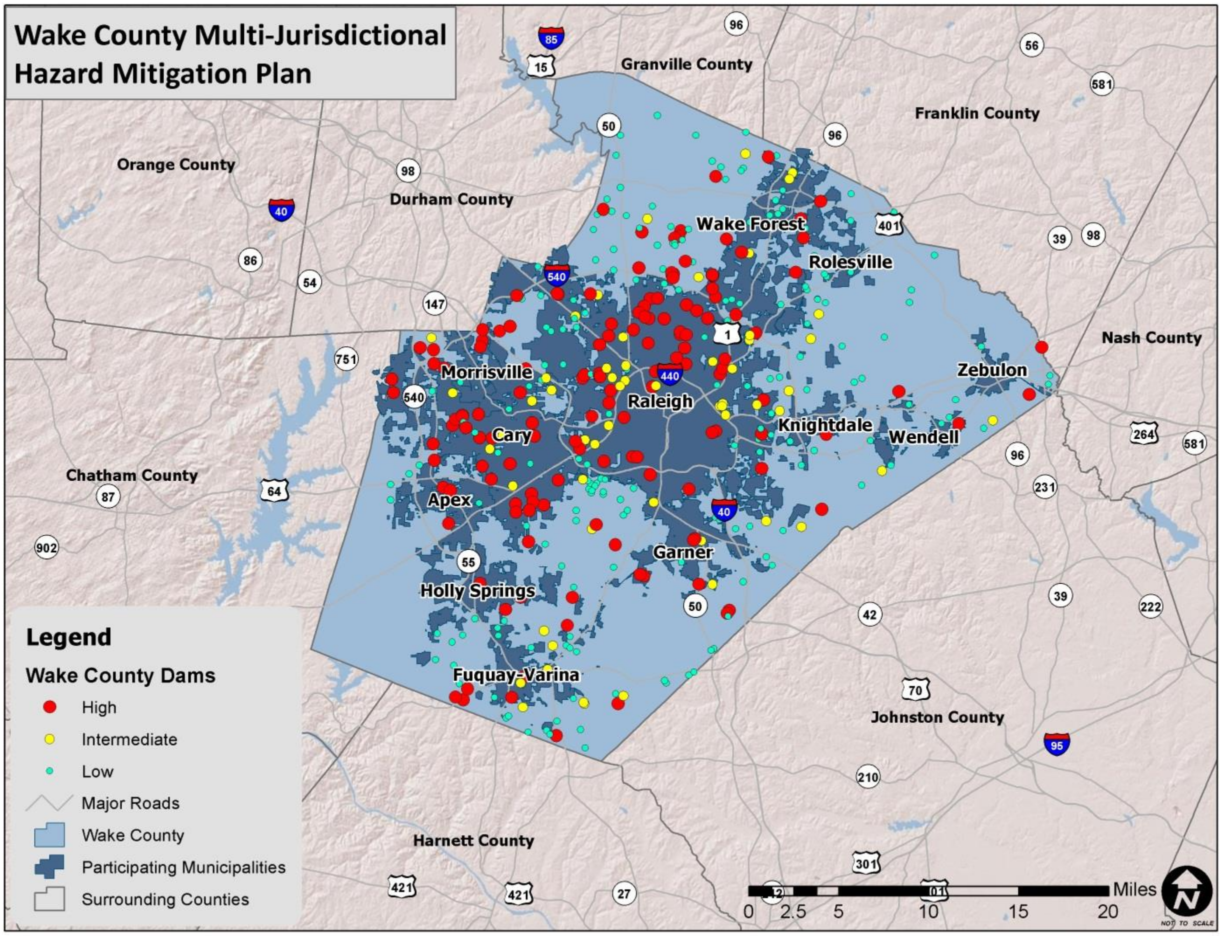
Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

According to the North Carolina Division of Land Management there are 3 dams in Rolesville.[13] **Figure I.6** shows the dam location and the corresponding hazard ranking for each. Of these dams, none are classified as high hazard potential. These high hazard dams are listed in **Table I.22**.

[13] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE I.6: WAKE COUNTY DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE I.22: ROLESVILLE HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Rolesville				
None reported				

Source: North Carolina Division of Land Resources, 2012

It should also be noted that the North Carolina dam classification regulations were recently updated. As a result of the change, more dams are generally classified as high hazard.

Historical Occurrences

No dam breaches were reported in Rolesville. However, several breach scenarios in the jurisdiction could cause substantial damage.

Probability of Future Occurrences
Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

I.2.12 Erosion

Location and Spatial Extent
Erosion in Rolesville is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Rolesville soils have greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Rolesville, particularly along the banks of rivers and streams, but it is not an extreme threat. No areas of concern were reported by the planning committee.

Historical Occurrences
Several sources were vetted to identify areas of erosion in Rolesville. This includes searching local newspapers, interviewing local officials, and reviewing the previous hazard mitigation plan. Little information could be found and erosion was not addressed in the previous Rolesville hazard mitigation plan.

Probability of Future Occurrences
Erosion remains a natural, dynamic, and continuous process for Rolesville, and it will continue to occur. The annual probability level assigned for erosion is possible (between 1 and 10 percent annually).

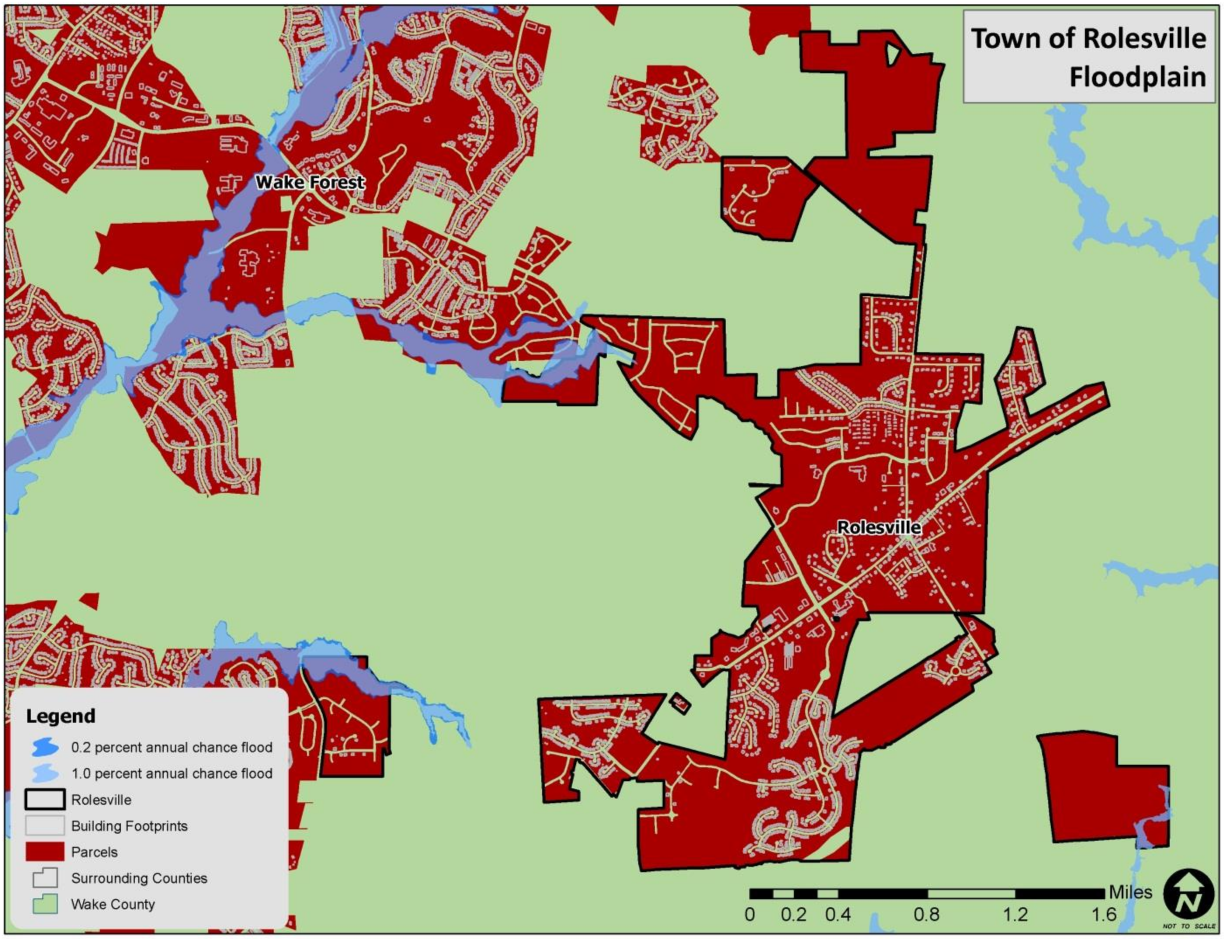
I.2.13 Flood

Location and Spatial Extent
There are areas in Rolesville that are susceptible to flood events. Special flood hazard areas in the jurisdiction were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[14] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 4 square miles that make up Rolesville, there are 0.07 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain).

These flood zone values account for 1.8 percent of the total land area in Rolesville. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas. **Figure I.7** illustrates the location and extent of currently mapped special flood hazard areas for Rolesville based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.

[14] The county-level DFIRM data used for Rolesville were updated in 2010.

FIGURE I.7: SPECIAL FLOOD HAZARD AREAS IN ROLESVILLE



Source: Federal Emergency Management Agency

Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported no events in Rolesville since 1993.[15] A summary of these events is presented in **Table I.23**. These events accounted for over $0 (2013 dollars) in property damage in the county.[16] Specific information on flood events, including date, type of flooding, and deaths and injuries, can be found in **Table I.24**.

TABLE I.23: SUMMARY OF FLOOD OCCURRENCES IN ROLESVILLE

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Rolesville	0	0/0	$0

Source: National Climatic Data Center

[15] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.
[16] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

TABLE I.24: HISTORICAL FLOOD EVENTS IN ROLESVILLE

	Date	Type	Deaths/ Injuries	Property Damage*
Rolesville				
None reported				
Source: National Climatic Data Center				

Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there have been 0 flood losses reported in Rolesville through the National Flood Insurance Program (NFIP) since 1978. A summary of these figures for the jurisdiction is provided in **Table I.25**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that additional instances of flood loss in Rolesville were either uninsured, denied claims payment, or not reported.

TABLE I.25: SUMMARY OF INSURED FLOOD LOSSES IN ROLESVILLE

Location	Flood Losses	Claims Payments
Rolesville	0	$0

Source: FEMA, NFIP

Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

As of July 2013, there are 0 non-mitigated repetitive loss properties located in Rolesville, which accounted for 0 losses and $0 in claims payments under the NFIP. Without mitigation, repetitive loss properties will likely continue to experience flood losses. **Table I.26** presents detailed information on repetitive loss properties and NFIP claims and policies for Rolesville.

TABLE I.26: SUMMARY OF REPETITIVE LOSS PROPERTIES IN ROLESVILLE

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Rolesville	0	-	0	$0	$0	$0	$0

Source: National Flood Insurance Program

Probability of Future Occurrences

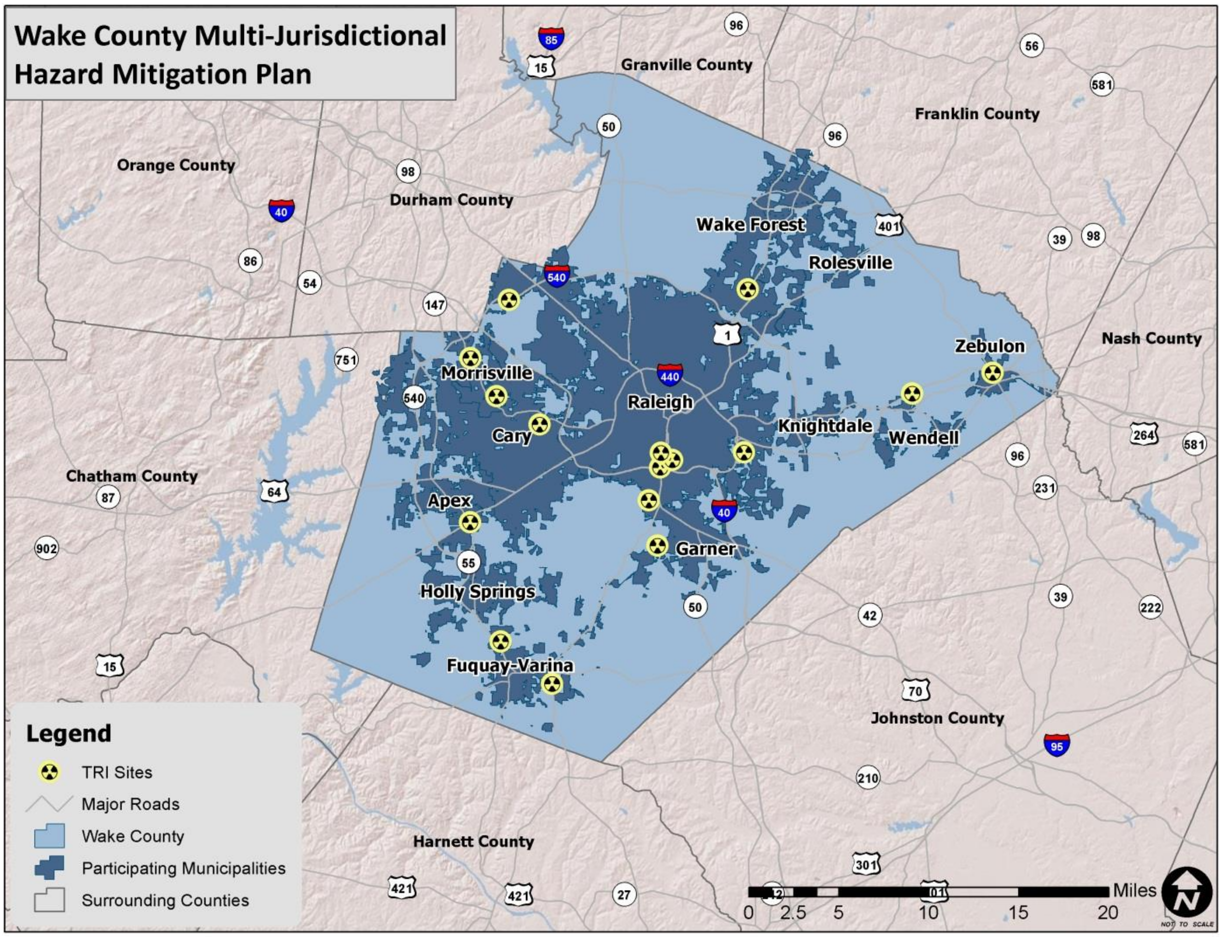
Flood events will remain a threat in areas prone to flooding in Rolesville, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability) The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above**,** which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

I.2.14 Hazardous Materials Incidents

Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Rolesville has no TRI sites as shown in **Figure I.8.**

FIGURE I.8: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the jurisdiction via roadways and rail. All roads that permit hazardous material transport are considered potentially at risk to an incident.

Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table I.27 presents detailed information on historic HAZMAT incidents reported in Rolesville.

TABLE I.27: SUMMARY OF HAZMAT INCIDENTS IN ROLESVILLE

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Rolesville							
None reported							

Source: USDOT PHMSA

Probability of Future Occurrences

Although there are no toxic release inventory sites in Rolesville, there are several roadways and rails that transport hazardous materials, so it is possible that a hazardous material incident may occur in the jurisdiction (between 1 percent and 10 percent annual probability). Local officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

I.2.15 Wildfire

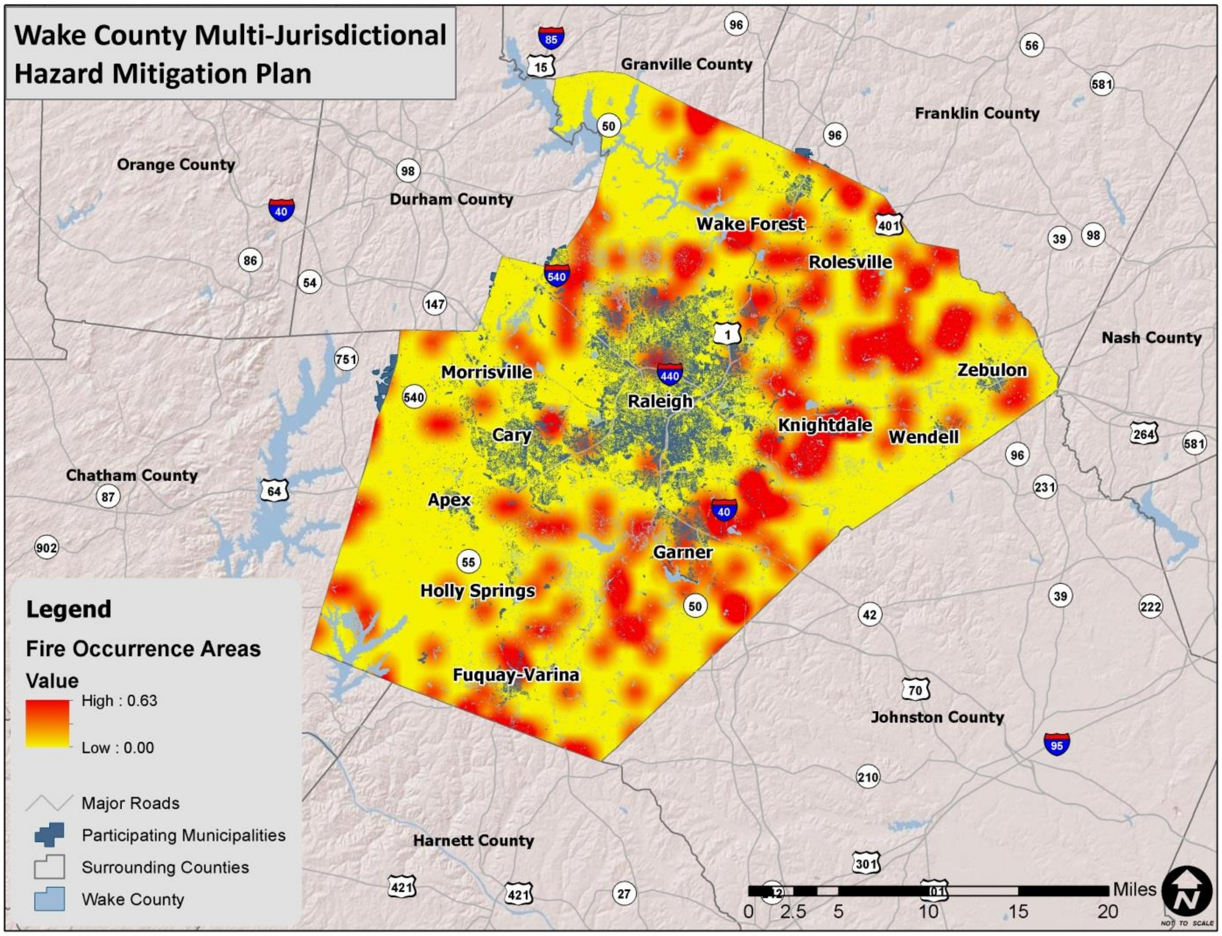
Location and Spatial Extent

The entire jurisdiction is at some risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas.

Historical Occurrences

Figure I.9 shows the Fire Occurrence Areas (FOA) in Rolesville based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. Therefore, even areas classified as at relatively high risk within the county are a relatively low risk compared to other areas of the state.

FIGURE I.9: HISTORIC WILDFIRE EVENTS IN ROLESVILLE



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of 16 wildfires annually which burn an average of 98 acres per year. The data indicates that most of these fires are small, averaging six acres per fire. **Table I.28** lists the number of reported wildfire occurrences in the county between the years 2003 and 2012.

TABLE I.28: HISTORICAL WILDFIRE OCCURRENCES IN ROLESVILLE

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Rolesville. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Rolesville for future wildfire events is possible (a 1 and 10 percent annual probability).

I.2.16 Nuclear Accident

Location and Spatial Extent

The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station.

Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 “Alerts” and 28 “Notice of Unusual Events” since 1986, which are shown in **Table I.29**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table I.29: SHEARON HARRIS EMERGENCY DECLARATION HISTORY

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on “B” Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).

Emergency Declaration	Date	Description
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of “A” Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - “B” diesel generator was being worked on; in accordance with test procedures, “A” diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported “Notice of Unusual Events” since 1986, which is shown in **Table I.30**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table I.30: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Probability of Future Occurrences
A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

I.2.17 Terror Threat

Location and Spatial Extent
A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table I.31** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

TABLE I.31 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food ▪ Banking and Finance ▪ Chemical ▪ Commercial Facilities ▪ Communications ▪ Critical Manufacturing ▪ Dams ▪ Defense Industrial Base ▪ Emergency Services ▪ Energy	▪ Government Facilities ▪ Healthcare and Public Health ▪ Information Technology ▪ National Monuments and Icons ▪ Nuclear Reactors, Materials, and Waste ▪ Postal and Shipping ▪ Transportation Systems ▪ Water

Historical Occurrences
Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

Probability of Future Occurrences
Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

I.2.18 Conclusions on Hazard Risk

The hazard profiles presented above were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and

experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

Hazard Extent

Table I.32 describes the extent of each natural hazard identified for Rolesville. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE I.32 EXTENT OF ROLESVILLE HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page I:4). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Rolesville has received this ranking three times over the fourteen year reporting period.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Rolesville was 1.75 inches. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), Rolesville is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Thunderstorm Wind/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Rolesville was reported at 50 knots (approximately 58 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). The greatest magnitude reported was an F0 (reported on March 6 2011).
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Rolesville. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is low in Rolesville.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). Of the 3 dams in Rolesville, none are classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records located in Rolesville.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 17.5 percent of the total land area in Rolesville. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second.
Other Hazards	
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incident reported in the region is 75 LGA released on the highway in Raleigh. It should be noted that larger events are possible.
Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).

Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

Priority Risk Index Results

In order to draw some meaningful planning conclusions on hazard risk for Rolesville, the results of the hazard profiling process were used to generate countywide hazard classifications according to a “Priority Risk Index” (PRI). More information on the PRI and how it was calculated can be found in Section 5.20.2.

Table I.33 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups and Coordinating Committee. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE I.33: SUMMARY OF PRI RESULTS FOR ROLESVILLE

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	**2.5**
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	**2.4**
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	**2.5**
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	**2.1**
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	**3.1**
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.7**
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	**2.5**
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2**
Landslide	Unlikely	Minor	Small	Less than 6 hours	Less than 6 hours	**1.5**
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	**1.8**
Flood	Likely	Critical	Small	6 to 12 hours	Less than 1 week	**2.8**
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	**2**
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	**2.6**
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	**2.4**

I.2.16 Final Determinations on Hazard Risk

The conclusions drawn from the hazard profiling process for Rolesville, including the PRI results and input from the Regional Work Groups and Coordinating Committee, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table I.34**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Rolesville. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment* and below in Section I.3. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE I.34: CONCLUSIONS ON HAZARD RISK FOR ROLESVILLE

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Nuclear Accident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

I.3 TOWN OF ROLESVILLE VULNERABILITY ASSESSMENT

This subsection identifies and quantifies the vulnerability of Rolesville to the significant hazards previously identified. This includes identifying and characterizing an inventory of assets in the county and assessing the potential impact and expected amount of damages caused to these assets by each identified hazard event. More information on the methodology and data sources used to conduct this assessment can be found in Section 6: *Vulnerability Assessment*.

I.3.1 Asset Inventory

Table I.35 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for Rolesville (study area of vulnerability assessment).[17]

[17] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

TABLE I.35: IMPROVED PROPERTY IN ROLESVILLE

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Rolesville	2,224	$541,541,860	1,432	$380,149,908

Table I.36 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in Rolesville. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. In addition, a list of secondary facilities was created to recognize the importance of these facilities in the event of a disaster. These facilities were not mapped, but it is important to recognize that they could be potentially impacted by nearly any of the identified hazards, especially those that are atmospheric or have no specific spatial delineation.

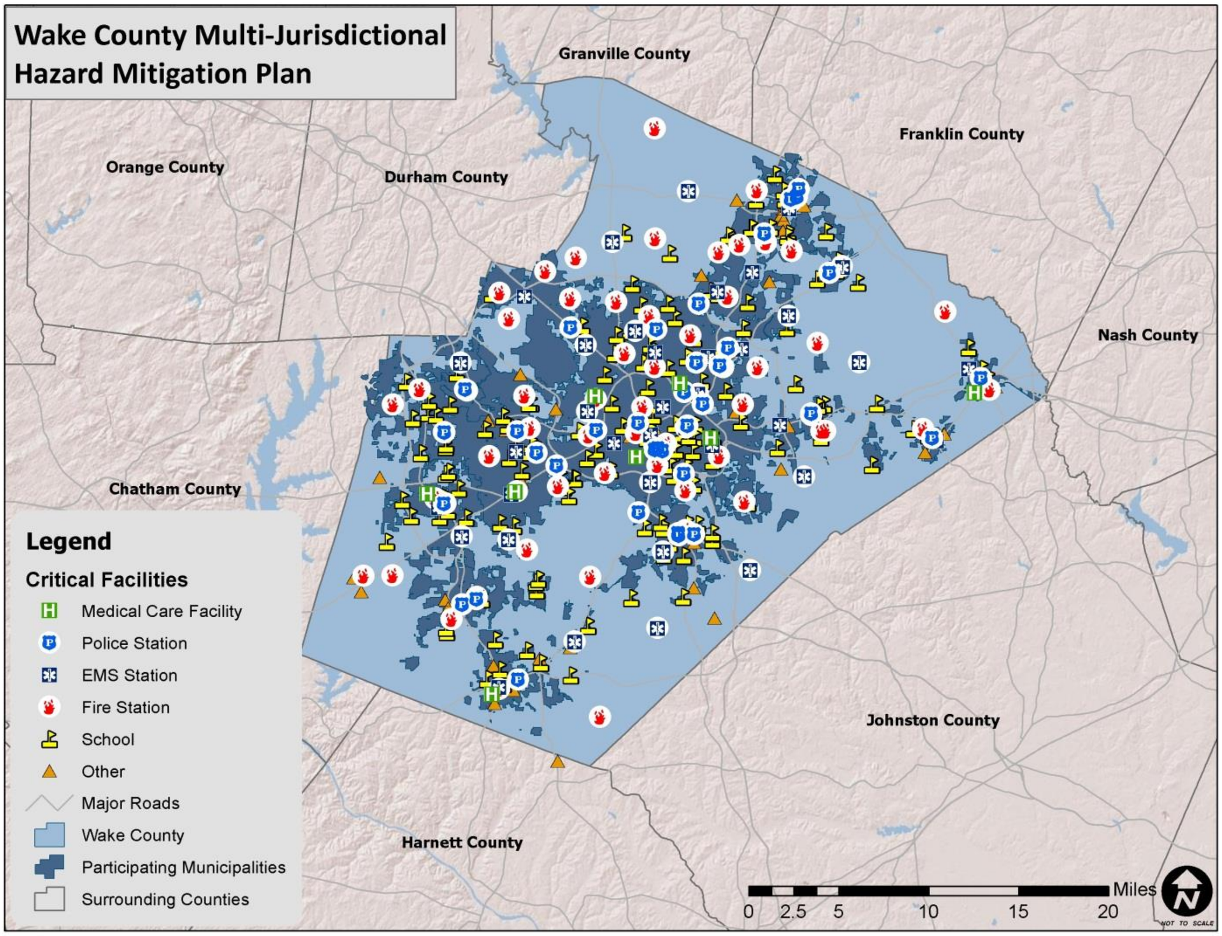
All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure I.10** shows the locations of the primary critical facilities in Wake County. **Table I.48**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility. As noted previously, this list is not all-inclusive and only includes information provided by the local government.

TABLE I.36: CRITICAL FACILITY INVENTORY IN ROLESVILLE

Location	Fire Stations	Police Stations	EMS Stations	Medical Care Facilities	Schools	Other
Rolesville	1	1	1	0	4	1

Source: Local Governments

FIGURE I.10: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: Local Governments

I.3.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Rolesville that are potentially at risk to these hazards.

Table I.37 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, limited the results to county-wide estimates. The total population in Rolesville according to Census data is 3,786 persons. Additional population estimates are presented above in Section I.1.

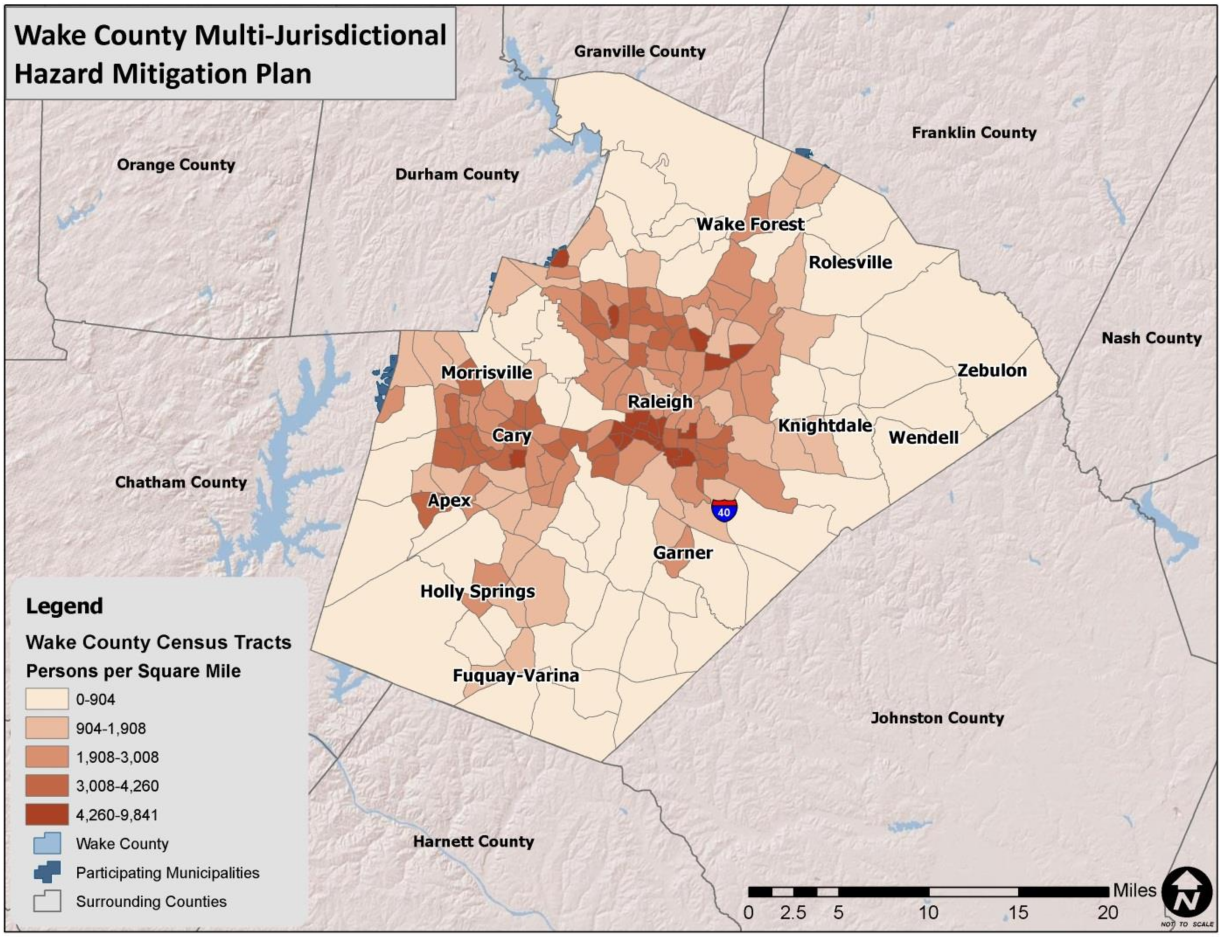
TABLE I.37: TOTAL POPULATION IN ROLESVILLE

Location	Total 2010 Population
Rolesville	3,786

Source: U.S. Census 2010

In addition, **Figure I.11** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[18]

FIGURE I.11: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

I.3.3 Vulnerability Assessment Results

As noted in Section 6: *Vulnerability Assessment*, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results, specific to Rolesville, are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total county exposure, and thus risk, was presented in **Table I.35**.

The annualized loss estimate for all hazards is presented at the end of this section in **Table I.47.**

The hazards presented in this section include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

[18] Population by census block was not available at the time this plan was completed.

Hurricane and Tropical Storm

Historical evidence indicates that Rolesville has a significant risk to the hurricane and tropical storm hazard. Several tracks have come near or traversed through the county, as shown and discussed in Section I.2.4.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes, and high winds and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table I.38.** Only losses to buildings are reported, in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE I.38: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table I.39.**

TABLE I.39: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Rolesville	73.8	82.9	100.6	107.0

Source: Hazus-MH 2.1

Social Vulnerability

Given equal susceptibility across the county, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Rolesville, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table I.48** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Rolesville. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

Earthquake

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table I.40** summarizes the findings.

TABLE I.40: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability

It can be assumed that all existing future populations are at risk to the earthquake hazard.

Critical Facilities

The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table I.48**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Rolesville. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

Landslide

In order to complete the vulnerability assessment for landslides in Rolesville, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section I.2.10), tax parcel and building footprint data, and GIS analysis. **Table I.41** presents the potential at-risk property where available. All areas of Rolesville are identified as low incidence areas by the USGS landslide data. Since there were no high incidence levels in the county, the moderate incidence level was used to identify different areas of concern for the analysis below.

TABLE I. 41: TOTAL POTENTIAL AT-RISK PARCELS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	**Moderate**		
Rolesville	0	0	$0

Source: USGS

Social Vulnerability
Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides.

Critical Facilities
No critical facilities are located in a moderate susceptibility area. A list of specific critical facilities and their associated risk can be found in **Table I.48** at the end of this section.

In conclusion, a landslide has the potential to impact existing and future buildings, facilities, and populations in Rolesville, though some areas are at a higher risk than others due to a variety of factors. For example, steep slopes and modified slopes bear a greater risk than flat areas. Specific vulnerabilities for county assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

Flood
Historical evidence indicates that Rolesville is susceptible to flood events. No flood events have been reported by the National Climatic Data Center resulting in $0 in damages. On an annualized level, these damages amounted to $0 for Rolesville.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for the county. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table I.42** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

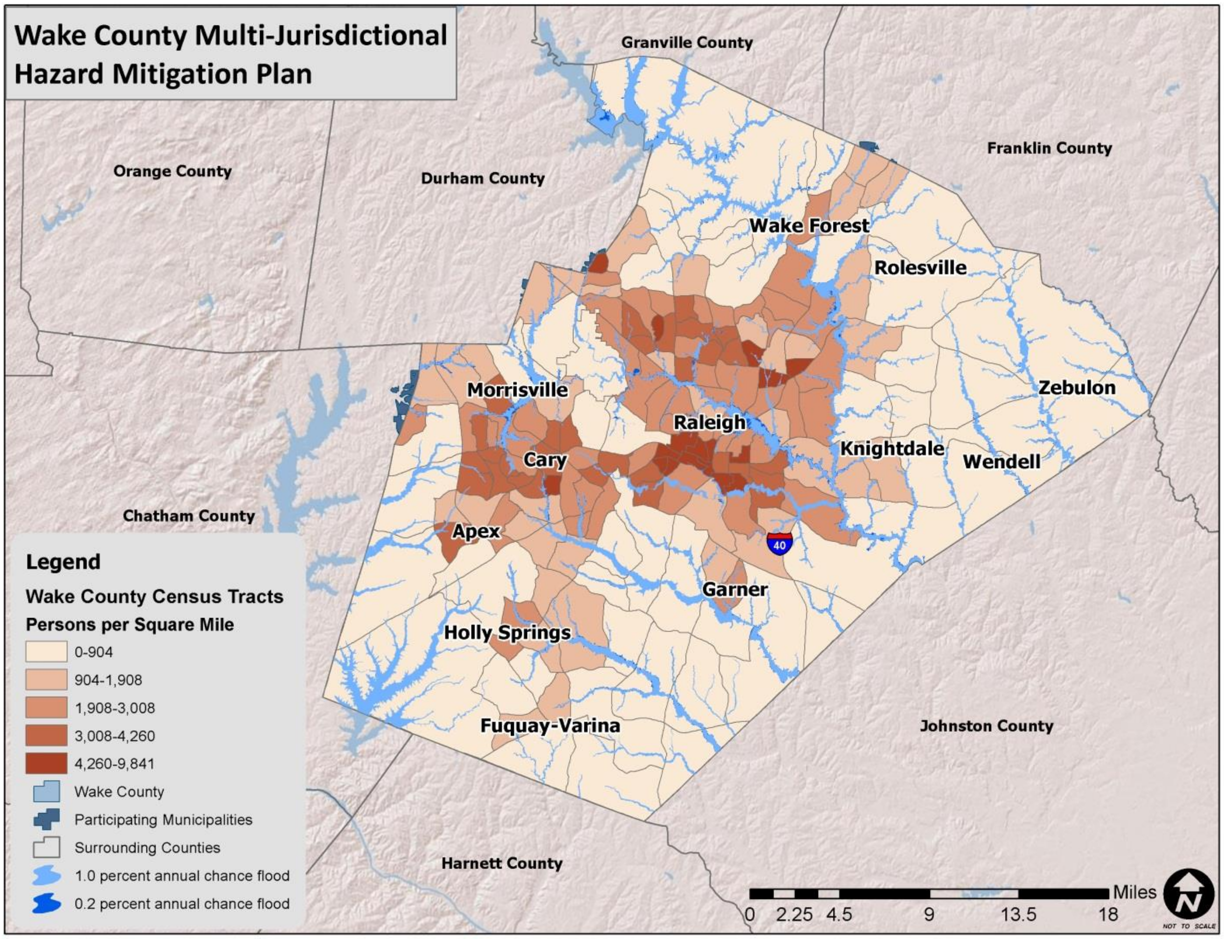
TABLE I.42: ESTIMATED EXPOSURE OF PARCELS TO THE FLOOD HAZARD

Location	1.0-percent ACF			0.2-percent ACF		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings
Rolesville	2	0	$0	0	0	$0

Source: FEMA DFIRM

Social Vulnerability
Since 2010 population was available at the tract level, it was difficult to determine a reliable figure on population at-risk to flood due to tract level population data. **Figure I.12** is presented to gain a better understanding of at risk population.

FIGURE I.12 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities

The critical facility analysis revealed that there are a no critical facilities located in the Rolesville 1.0-percent annual chance floodplain and 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. A list of specific critical facilities and their associated risk can be found in **Table I.48** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings and populations in Rolesville, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

Hazardous Materials Incident

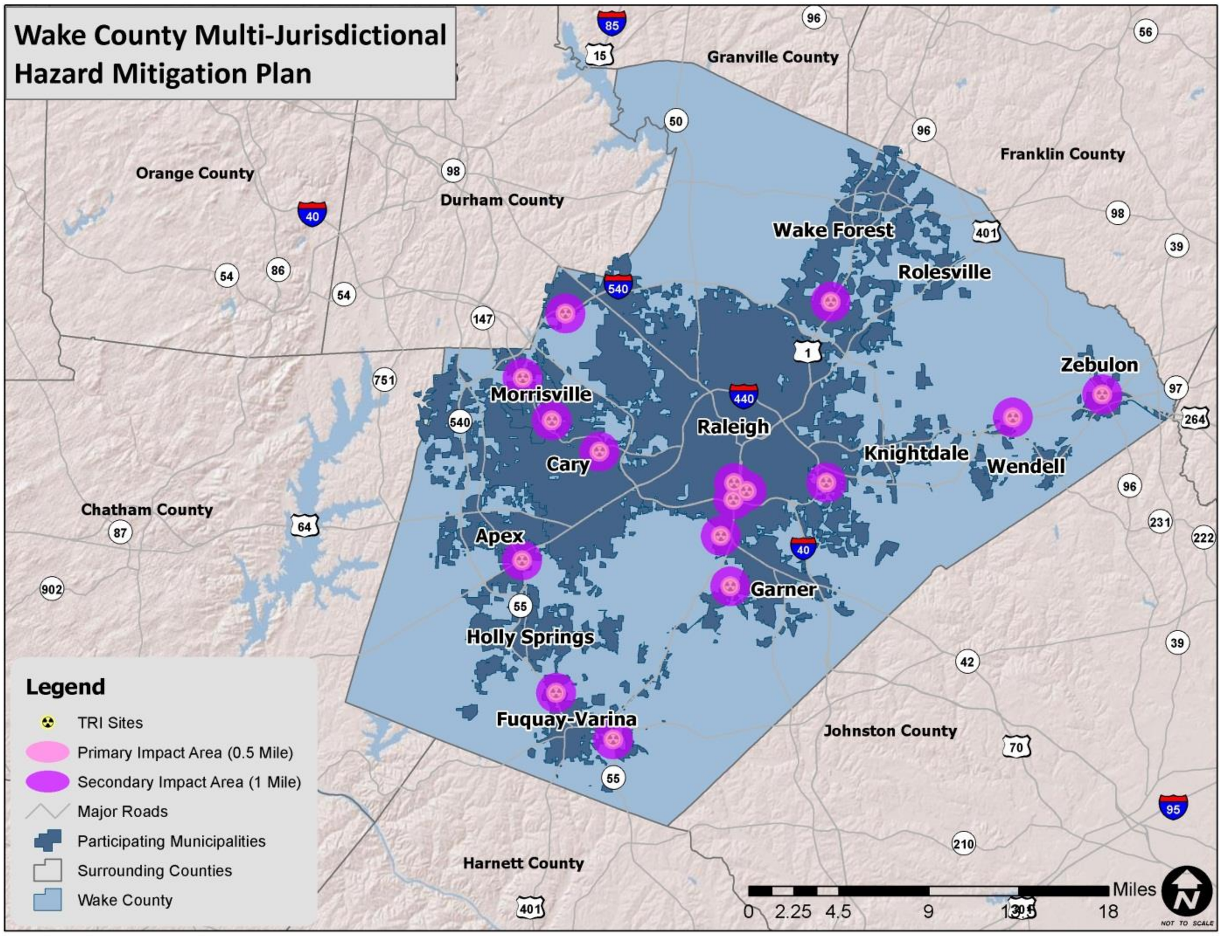
Although historical evidence and existing Toxic Release Inventory sites indicate that Rolesville is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Rolesville.

Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[19] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Rolesville, along with buffers, were used for analysis as shown in **Figure I.13.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the GIS buffer analysis. **Figure I.14** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table I.43** (fixed sites), **Table I.44** (mobile road sites) and **Table I.45** (mobile railroad sites).[20]

[19] This type of analysis will likely yield inflated results (generally higher than what is actually reported after an event).
[20] Note that parcels included in the 1.0-mile analysis are also included in the 0.5-mile analysis.

FIGURE I.13 : TRI SITES WITH BUFFERS IN ROLESVILLE



Source: EPA

TABLE I.43: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Rolesville	0	0	$0	0	0	$0

FIGURE I.14 : MOBILE HAZMAT BUFFERS IN ROLESVILLE

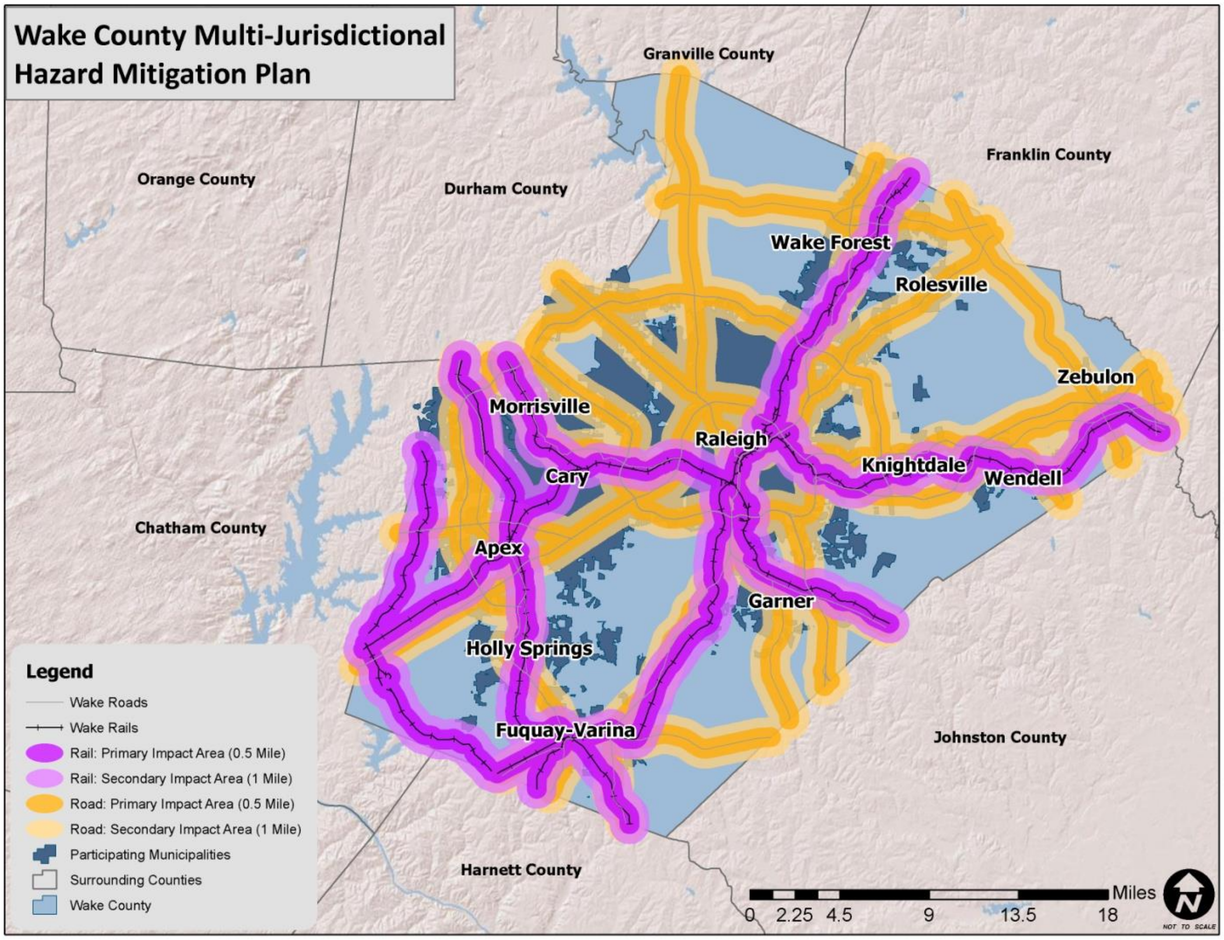


TABLE I.44: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Rolesville	1,178	879	$215,548,841	1,927	1,416	$347,126,021

TABLE I.45: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Rolesville	0	0	$0	0	0	$0

Social Vulnerability
Given high susceptibility across the jurisdiction, it is assumed that the total population is at risk to a hazardous materials incident. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities
Fixed Site Analysis:
The critical facility analysis for fixed TRI sites revealed that no critical facilities are located in a HAZMAT risk zone. A list of specific critical facilities and their associated risk can be found in **Table I.48** at the end of this section.

Mobile Analysis:
The critical facility analysis for road and railroad transportation corridors in Rolesville revealed that there are 7 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 7 facilities. The railroad buffer areas include no facilities. It should be noted that many of the facilities located in the buffer areas for railroad may also be located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table I.48** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Rolesville. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc. Further, incidents from neighboring jurisdictions could also have an impact.

Wildfire
Although historical evidence indicates that Rolesville is susceptible to wildfire events, there are few reports of damage. Upon conversion of the wildfire risk data (see Section 6: *Vulnerability Assessment*) and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the jurisdiction should be assumed to be very low. As such, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the county.

Social Vulnerability
All areas have relatively equal vulnerability and there is low susceptibility across the entire county.
It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities
The critical facility analysis revealed that there are no critical facilities located in wildfire areas of concern. It should be noted, however, that several factors could impact the spread of a wildfire putting all facilities at risk. A list of specific critical facilities and their associated risk can be found in **Table I.48** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Rolesville.

Nuclear Accident

The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table I.46** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE I.46: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[21]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[22]
Rolesville	0	0	$0	2,224	1,432	$380,149,908

Social Vulnerability

Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in the 10-mile nuclear buffer area in Rolesville.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in Rolesville, though areas closer to the power plant are at a higher risk than others. All structures are at some risk given that they are all located within at least the 50-mile buffer area.

Conclusions on Hazard Vulnerability

Table I.47 presents a summary of annualized loss for each hazard in Rolesville. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, although an annualized loss was determined through the damage reported through historical occurrences at the municipal level, it is likely that the county-wide estimate (found in Section 6: *Vulnerability Assessment*) is potentially a better estimate. These values

[21] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.
[22] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

should be used as an additional planning tool or measure risk for determining hazard mitigation strategies.

TABLE I.47: ANNUALIZED LOSS FOR ROLESVILLE*

Event	Rolesville
Dam Failure	Negligible
Drought	Negligible
Erosion	Negligible
Extreme Heat	Negligible
Hail	Negligible
Hurricane & Tropical Storm	Negligible
Landslide	Negligible
Lightning	Negligible
Thunderstorm Wind/High Wind[23]	Negligible
Tornado	$54,637
Winter Storm & Freeze	Negligible
Flood	Negligible
Earthquake	Negligible
HAZMAT Incident	Negligible
Wildfire	Negligible
Nuclear Accident	Negligible
Terror Threat	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table I.48** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

[23] The annualized losses for these hazards were combined.

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TABLE I.48: AT-RISK CRITICAL FACILITIES IN ROLESVILLE

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
ROLESVILLE																								
ROLESVILLE MAIN	EMS STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
ROLESVILLE	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
ROLESVILLE TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X							X	X					X	X
ROLESVILLE	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
ROLESVILLE ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
SANFORD CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
ROLESVILLE HS	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
ROLESVILLE MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X

Secondary Critical Facilities are listed in slight contrast to Critical Facilities as their continued function has not been deemed as critical as primary facilities in the event of a disaster, but these facilities are extremely important. A loss of function to one of these facilities would have a definitively greater negative impact on the community's ability to respond to and recover from a disaster than a loss of function at other facilities/structures within the jurisdiction. In **Table I.49**, these facilities have been classified as either Significant Community Locations/Sheltering Centers or as Critical Resources Management Facilities. These facilities are all vulnerable to any of the atmospheric hazards and many are also likely vulnerable to other hazards identified above, though no locational analysis was carried out to this end.

TABLE I.49: ROLESVILLE SECONDARY CRITICAL FACILITIES

Facility Name	Address*	Type
Rolesville		
US Post Office		Significant Community Location or Sheltering Center
Water Booster Station	Bowling Street	Critical Resources Management (Energy, Water, etc.)
Sewer Pump Station	Averett at Jones Dairy	Critical Resources Management (Energy, Water, etc.)
Water Tower	730 South Main Street	Critical Resources Management (Energy, Water, etc.)

**Some address information could not be provided or was not applicable to the facility*

I.4 TOWN OF ROLESVILLE CAPABILITY ASSESSMENT

This subsection discusses the capability of the Town of Rolesville to implement hazard mitigation activities. More information on the purpose and methodology used to conduct the assessment can be found in Section 7: *Capability Assessment*.

I.4.1 Planning and Regulatory Capability

Table I.50 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the Town of Rolesville. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE I.50: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning Tool/Regulatory Tool	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan (Parks & Rec/Greenway Plan	Stormwater Management Plan/Ordinance	Natural Resource Protection Plan	Flood Response Plan	Emergency Operations Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	National Flood Insurance Program (NFIP)	NFIP Community Rating System
Rolesville	✓	✓		✓	✓			✓				✓			✓	✓	✓	✓		✓	✓	✓	

A more detailed discussion on the town's planning and regulatory capabilities follows.

Emergency Management

Hazard Mitigation Plan
The Town of Rolesville has previously adopted a hazard mitigation plan.

Emergency Operations Plan
The Town of Rolesville has adopted the Wake County Emergency Operations Plan.

General Planning

Comprehensive Land Use Plan
The Town of Rolesville has adopted the *Rolesville Community Plan* (or Land Use Plan as it is sometimes called).

Capital Improvements Plan
The Town of Rolesville has a capital improvement plan in place.

Zoning Ordinance
The Town of Rolesville includes zoning regulations as part of the local unified development ordinance.

Subdivision Ordinance
The Town of Rolesville also includes subdivision regulations as part of the local unified development ordinance.

Building Codes, Permitting, and Inspections
North Carolina has a state compulsory building code which applies throughout the state. Wake County provides building inspections through contractual agreement for the Town of Rolesville.

Floodplain Management

Table I.51 provides NFIP policy and claim information the Town of Rolesville.

TABLE I.51: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
Rolesville	07/31/01	04/16/07	9	$2,380,000	0	$0

Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Flood Damage Prevention Ordinance
All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. The Town of Rolesville participates in the NFIP and has adopted flood damage prevention regulations.

Open Space Management Plan
The Town of Rolesville has adopted an open space and greenways plan.

Stormwater Management Plan
The Town of Rolesville has not adopted a stormwater management plan; however, the town includes stormwater management regulations as part of the local unified development ordinance.

I.4.2 Administrative and Technical Capability

Table I.52 provides a summary of the capability assessment results for the Town of Rolesville with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in the town with the specified knowledge or skill.

TABLE I.52: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	Planners with knowledge of land development/land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency Manager	Floodplain Manager	Land Surveyors	Scientists familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Resource development staff or grant writers
Rolesville	✓	✓	✓	✓	✓		✓	✓	✓	

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

I.4.3 Fiscal Capability

Table I.53 provides a summary of the results for the Town of Rolesville with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plan.

TABLE I.53: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes (or taxing districts)	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.
Rolesville	✓	✓	✓						✓	✓

I.4.4 Political Capability

The previous hazard mitigation plan indicates that elected officials of the Town of Rolesville are in agreement that implementation of the hazard mitigation plan is a necessary step to minimize damages from natural hazards. The Board of Commissioners supports the need for hazard mitigation to reduce future loss of life and property and will vigorously support hazard mitigation efforts. The citizens, property owners, business owners, as well as elected officials of the Town of Rolesville are confident in the need for a hazard mitigation plan. The Mayor of Rolesville along with the elected board members continually strive to make the Town of Rolesville a safer community and see the hazard mitigation plan as a means to help achieve that goal.

I.4.5 Conclusions on Local Capability

Table I.54 shows the results of the capability assessment using the designed scoring methodology described in Section 7: *Capability Assessment*. The capability score is based solely on the information found in existing hazard mitigation plan and readily available on the town's government website. According to the assessment, the local capability score for the town is 38, which falls into the moderate capability ranking.

TABLE I.54: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
Rolesville	38	Moderate

I.5 TOWN OF ROLESVILLE MITIGATION STRATEGY

This subsection provides the blueprint for Rolesville to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Regional Work Groups and the findings and conclusions of the capability assessment and risk assessment. Additional Information can be found in Section 8: *Mitigation Strategy* and Section 9: *Mitigation Action Plan*.

I.5.1 Mitigation Goals

Rolesville developed seven mitigation goals in coordination with Wake County and the other participating municipalities. The county-wide mitigation goals are presented in **Table I.55**.

TABLE I.55: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

I.5.2 Mitigation Action Plan

The mitigation actions proposed by Rolesville are listed in the following Mitigation Action Plan.

Town of Rolesville Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	UDO: Continue to provide stream and creek buffers, and floodplain and wetland protection.	Flood	High	Rolesville Planning	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
P-2	UDO: Resource Conservation Areas (RCA) – Continue to protect floodplains, streams, and creeks.	Flood	High	Rolesville Planning	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
P-3	UDO: Subdivision Standards – Continue to provide protection for residential areas by not allowing residential lots in the floodplain.	Flood	High	Rolesville Planning	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
P-4	UDO – Ensure buildings are minimum 2' above base flood elevation.	Flood	High	Wake County	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
P-5	UDO: Flood Damage Prevention Overlay District – Continue to restrict and prohibit uses which are dangerous to health, safety, and property. Uses vulnerable to floods are protected.	Flood	High	Rolesville Planning	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
P-6	UDO: Flood Damage Prevention – Ensure control is provided for filling, grading and dredging within floodplains by working with necessary State and Federal Agencies.	Flood	Moderate	Rolesville Planning and Town Manager	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
P-7	Ensure road standards maintained in disaster preparation for possible use as evacuation routes.	All	Moderate	Rolesville Planning	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-8	Provide adequate water supply through storage and interconnection with other public water systems.	Drought	Moderate	City of Raleigh	Local	Completed	As of 2014, the City of Raleigh maintains all water and sewer facilities as part of their greater system. This action will be removed in the next update.
P-9	Provide backup power for all critical public facilities (wastewater treatment plant, sewer pump stations, Public Works and Utilities building, and other critical public buildings).	All	Moderate	City of Raleigh	Local	2019	As of 2014, the City of Raleigh maintains all water and sewer facilities as part of their greater system. The town will continue to identify facilities that need backup power
P-10	Maintain major town transportation routes through snow and ice removal contracts and equipment.	Severe Winter Storms	Moderate	Rolesville Administration	Local	Completed	As of 2014, the town maintains standing contracts for snow and ice removal when necessary. This action will be removed in the next update.
P-11	Require Engineered Storm Water Control Structures where necessary.	Flood	Moderate	Rolesville Planning	Local	Completed	Since 2010, the town has partnered with Wake County to adopt a comprehensive storm water ordinance. Wake County reviews all development for compliance. This action will be removed in the next update.
P-12	Town regularly backs-up information pertaining to Town government in case of an emergency.	All	Moderate	Rolesville Town Manager	Local	Completed	As of 2014, the town continues to back up electronic information on a regular basis. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-13	Transportation Plan – Continue to address disaster preparedness (evacuation) through road interconnectivity, paved roads, and widening of roads.	All	Moderate	Rolesville Planning	Local	2017	From 2010 to 2014, several new streets have been built and many others have been resurfaced. Going forward, roads will continue to be evaluated for their use in disaster preparedness and the Transportation Plan will be updated accordingly.
Natural Resource Protection							
NRP-1	UDO: Continue to require engineered stormwater controls including stream and wetland protection.	Flood	Moderate	Local	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
NRP-2	UDO: Flood Damage Prevention Overlay District - continue to prohibit any development in floodway to protect floodplains and wetlands.	Flood	Moderate	Local	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
NRP-3	Develop Open Space Ordinance to protect wildlife habitat.	All	Moderate	Local	Local	Completed	As of 2014, this policy is still in effect and any new development is subject to this policy. This action will be removed in the next update.
NRP-4	UDO: Incorporate regulations for illicit discharge control in Phase II Stormwater Management Plan.	Flood	Moderate	Local	Local	Completed	Since 2010, the town has partnered with Wake County to adopt a comprehensive storm water ordinance. Wake County reviews all development for compliance. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-5	UDO -Stream Dumping – Through the NPDES Phase II Stormwater program, the Town will design and implement an illicit discharge program which will enforce regulations against illegal stream dumping.	Flood	Low	Local	Local	Completed	Since 2010, the town has partnered with Wake County to adopt a comprehensive storm water ordinance. Wake County reviews all development for compliance. This action will be removed in the next update.
Emergency Services							
ES-1	Emergency Operations Command Post Center – established when natural hazard is imminent. Center coordinates evacuations, sheltering, staging areas for equipment, manpower, and needed supplies. Equipment includes internet access, telephone, wireless communications, radio and backup supplied by emergency batteries and/or generators.	All	High	Rolesville Town Manager, Fire, EMS, and Police	Local	Completed	As of 2014, the EOCPC is still maintained and operated out of the Rolesville Rural Fire Dept. station as needed. This action will be removed in the next update.
ES-2	Ongoing provision of emergency assistance as needed.	All	High	Rolesville Fire, EMS, and Police	Local	Completed	As of 2014, these actions are ongoing as they occur daily. This action will be removed in the next update.
ES-3	Ensure hazard warning methods include television, radio, internet and, if needed, emergency vehicles with loud speaker systems.	All	Moderate	Rolesville Fire, EMS, and Police	Local	Completed	As of 2014, website, telephone (Reverse 911),and email notifications currently available from the Town. This action will be removed in the next update.
ES-4	Maintain open lines of communication between all branches of emergency response personnel.	All	Moderate	Rolesville Fire, EMS and Police	Local	Completed	As of 2014, these actions are ongoing as they occur daily. This action will be removed in the next update.
ES-5	Prepare for emergency situations – weather station, local weather warning system, and emergency management.	All	Moderate	Rolesville Fire	Local	Completed	As of 2014, these actions are ongoing as they occur daily. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-6	Standard Operating Guidelines – collection of procedures to be followed during emergencies.	All	High	Rolesville Fire	Local	Completed	As of 2014, these actions are ongoing as they occur daily. This action will be removed in the next update.
ES-7	Continue Pre-Fire Incident Plan program for all commercial facilities within the Town limits.	All	High	Rolesville Fire	Local	Completed	As of 2014, these actions are ongoing as they occur daily. This action will be removed in the next update.
ES-8	Maintain contact information for local businesses in case of an emergency.	All	High	Rolesville Fire	Local	Completed	As of 2014, these actions are ongoing as they occur daily. This action will be removed in the next update.
ES-9	Continue to evaluate and improve response and recovery methods following each hazard event.	All	High	Rolesville Fire, Police, and Town Manager	Local	Completed	The town continues to evaluate and improve response and recovery methods as needed. This action will be removed in the next update.
ES-10	Health and safety maintenance – provide assistance with security and post storm clean-up.	All	High	Rolesville Fire, Police, and Town Manager	Local	Completed	As of 2014, assistance is provided as needed. This action will be removed in the next update.
ES-11	Post disaster response – building inspections personnel will respond as needed.	All	Moderate	Wake County	Local	Completed	Wake County inspections will continue to provide personnel and inspections as needed for disaster response. This action will be removed in the next update.
ES-12	Counseling – Police psychologist and Critical Incident Stress Debriefing Team training to provide debriefing sessions for personnel.	All	High	Rolesville Public Safety	Local	Completed	As of 2014, assistance is provided as needed. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Public Education and Awareness							
PEA-1	Town website - develop hazard mitigation section covering such items as public access, evacuation routes, emergency contact numbers, and detailed weather reports in case of emergency,	All	Moderate	Rolesville Adminsitration	Local	2016	Since 2010, the Town's website has been updated substantially to include some, but not all, of these items. The town will work to update the website with other items in the future.
PEA-2	Hazard Disclosure – Maintain geographic information systems (GIS) map to increase public awareness of known hazard locations.	Flood	Moderate	Rolesville Planning	Local	Completed	The Town's GIS library is continually updated with data from Wake County. These updates will continue monthly and as needed. This action will be removed in the next update.
PEA-3	Develop planned park to include nature trails and environmental education center.	Flood	High	Rolesville Town Manager	Local Wake County	2019	As of 2014, Mill Bridge Nature Park (with trails) is open to the public. Funding for the education center has not yet become available.
PEA-4	Town Hall – Maintain and update hazard information accessible to the public.	All	Moderate	Rolesville Planning	Local	2016	As of 2014, a copy of the town's hazard mitigation plan is maintained online as well as hardcopy (at town hall) for public viewing. The town will look to improve public education and information sharing through additional channels.
PEA-5	Continue to provide flood maps for public use with staff continuing to be available for public assistance.	Flood	High	Rolesville Planning	Local	Completed	As of 2014, FIRM maps are available at town hall for review and planning staff are always available for public assistance during regular business hours (8am-5pm M-F). This action will be removed in the next update.

Annex J
Town of Wake Forest

This annex includes jurisdiction-specific information for the Town of Wake Forest. It consists of the following five subsections:

- J.1 Town of Wake Forest Community Profile
- J.2 Town of Wake Forest Risk Assessment
- J.3 Town of Wake Forest Vulnerability Assessment
- J.4 Town of Wake Forest Capability Assessment
- J.5 Town of Wake Forest Mitigation Strategy

J.1 TOWN OF WAKE FOREST COMMUNITY PROFILE

J.1.1 Geography and the Environment

Wake Forest is town located in Wake County in the state of North Carolina. It was incorporated in 1880 and was originally named for the college that was opened in the 19th century. Although the college later moved to Winston-Salem, the town remains one of the fastest growing suburbs in the country.

Overall, Wake County is known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Summer temperatures generally venture into the 90s for highs and cool off to the 70s at night. Winter temperatures in can drop to below freezing but generally highs are in the 50s. Rainfall is most common in the summer months but occurs consistently throughout the year.

J.1.2 Population and Demographics

According to the 2010 Census, Wake Forest has a population of 30,117 people. The jurisdiction has seen exceptional growth between 2000 and 2010, and the population density is almost 2,200 people per square mile. Population counts from the US Census Bureau for 1990, 2000, and 2010 are presented in **Table J.1**.

TABLE J.1: POPULATION COUNTS FOR WAKE FOREST

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
WAKE FOREST	5,769	12,588	30,117	139.25%

Source: US Census Bureau

The racial characteristics of the jurisdiction are presented in **Table J.2**. Whites make up the majority of the population in the jurisdiction, accounting for nearly 80 percent of the population.

TABLE J.2: DEMOGRAPHICS OF WAKE FOREST

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
WAKE FOREST	77.3%	15.3%	0.4%	7.0%	5.1%

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

J.1.3 Housing

According to the 2010 US Census, there are 11,370 housing units in Wake Forest, the majority of which are single family homes or mobile homes. Housing information for the jurisdiction is presented in **Table J.3**.

TABLE J.3: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Seasonal Units, Percent (2010)	Median Home Value (2006-2010)
WAKE FOREST	5,091	11,370	7.5%	$255,500

Source: US Census Bureau

J.1.4 Infrastructure

Transportation
There are several major roadways that residents of Wake Forest utilize. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs, one of which is I-540/NC-540 which is a partly completed loop that connects the jurisdiction to many of the other municipalities. In addition to the Interstate, there are many major highways that residents of the municipality utilize. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways in the include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities
Electrical power in the jurisdiction is provided by two entities and Duke Energy and Wake Electric Membership Corporation with Duke Energy providing service to a majority of the service. Water and sewer service is provided by two main entities as well: The City of Raleigh Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

Community Facilities

There are a number of buildings and community facilities located throughout Wake Forest. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 4 fire stations, 4 police stations, and 8 public schools located within the county. There is one medical care facility located in the municipality

Citizens also have access to several parks, including three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the county, including the American Tobacco Trail which is a rails to trails project that is open to a wide variety of non-motorized uses.

J.1.5 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land as parks. There are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the jurisdiction consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

J.1.6 Employment and Industry

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

J.2 TOWN OF WAKE FOREST RISK ASSESSMENT

This subsection includes hazard profiles for each of the significant hazards identified in Section 4: *Hazard Identification* as they pertain to Wake Forest. Each hazard profile includes a description of the hazard's location and extent, notable historical occurrences, and the probability of future occurrences. Additional information can be found in Section 5: *Hazard Profiles*.

J.2.1 Drought

Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, Wake Forest has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that the county would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Historical Occurrences

According to the North Carolina Drought Monitor, Wake Forest has had drought occurrences all of the last fourteen years (2000-2013). **Table J.4** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE J.4: HISTORICAL DROUGHT OCCURRENCES IN WAKE FOREST

Abnormally Dry | **Moderate Drought** | **Severe Drought** | **Extreme Drought** | **Exceptional Drought**

	Wake Forest
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that Wake Forest has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

J.2.2 Extreme Heat

Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to any geographic or political boundaries. All of Wake Forest is susceptible to extreme heat conditions.

Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Wake Forest. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the region. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the county. The most centralized location is in Raleigh at North Carolina State University. **Table J.5** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table J.5: Average Maximum Temperature in Raleigh, Wake County

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

J.2.3 Hailstorm

Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Wake Forest is uniformly exposed to severe thunderstorms; therefore, all areas are equally exposed to hail which may be produced by such storms.

Historical Occurrences

According to the National Climatic Data Center, 8 recorded hailstorm events have affected Wake Forest since 1993.[1] **Table J.6** is a summary of the hail events in Wake Forest. **Table J.7** provides detailed information about each event that occurred. In all, hail occurrences resulted in $0 (2013 dollars) in property damages. Hail ranged in diameter from 0.75 inches to 1.75 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value.

Table J.6: Summary of Hail Occurrences in Wake Forest

Location	Number of Occurrences	Property Damage (2013)
Wake Forest	8	$0

[1] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Wake Forest. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

Location	Number of Occurrences	Property Damage (2013)

Source: National Climatic Data Center

TABLE J.7: HISTORICAL HAIL OCCURRENCES IN WAKE FOREST

	Date	Magnitude	Deaths/Injuries	Property Damage*
Wake Forest				
WAKE FOREST	5/27/1996	0.75 in.	0/0	$0
WAKE FOREST	4/21/1997	0.75 in.	0/0	$0
WAKE FOREST	6/3/1998	1.25 in.	0/0	$0
WAKE FOREST	6/1/2002	0.75 in.	0/0	$0
WAKE FOREST	4/22/2006	1.75 in.	0/0	$0
WAKE FOREST	4/22/2006	1.75 in.	0/0	$0
WAKE FOREST	4/15/2007	0.88 in.	0/0	$0
WAKE FOREST	6/9/2007	0.88 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that Wake Forest has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the county.

J.2.4 Hurricane and Tropical Storm

Location and Spatial Extent

Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Wake Forest. The entire jurisdiction is equally susceptible to hurricane and tropical storms.

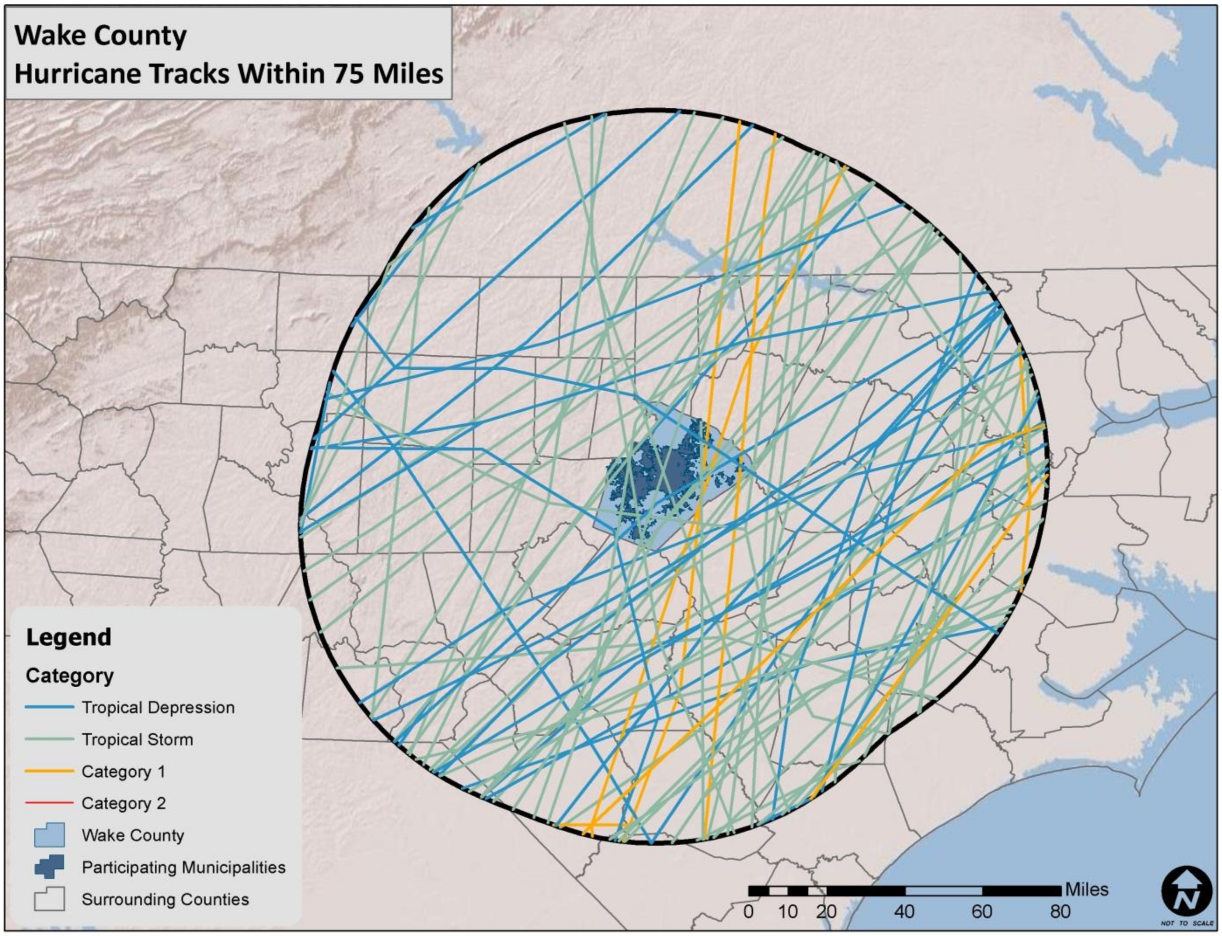
Historical Occurrences

According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[2] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms have traversed directly through Wake County as shown in **Figure J.1**. **Table J.8** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

[2] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

FIGURE J.1: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE J.8: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1
1882	NOT NAMED	53	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm
1959	CINDY	26	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression
2008	HANNA	40	Tropical Storm

Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Wake Forest between 1950 and 2013. These storms are listed in **Table J.9** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE J.9: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made in 1996 (Hurricane Fran), 1999 (Hurricane Floyd), and 2003 (Hurricane Isabel) for the county.[3]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Tropical Storm Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

Probability of Future Occurrences
Given the inland location of the jurisdiction, it is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Wake Forest. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the jurisdiction is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

[3] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

J.2.5 Lightning

Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Wake Forest is uniformly exposed to lightning.

Historical Occurrences

According to the National Climatic Data Center, there has been one recorded lightning event in Wake Forest since 1950, as listed in summary **Table J.10** and detailed in **Table J.11**.[4] However, it is certain that more lightning events have in fact impacted the jurisdiction. Many of the reported events are those that caused damage, and it should be expected that damages are likely much higher for this hazard than what is reported.

TABLE J.10: SUMMARY OF LIGHTNING OCCURRENCES IN WAKE FOREST

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Wake Forest	1	0/0	$55,838

Source: National Climatic Data Center

TABLE J.11: HISTORICAL LIGHTNING OCCURRENCES IN WAKE FOREST

	Date	Deaths/Injuries	Property Damage*	Details
Wake Forest				
WAKE FOREST	1/16/1998	0/0	$55,838	Lightning struck a brick house on Seawell Drive in Wake Forest about 20 miles northeast of Raleigh during the early afternoon. The lightning bolt hit the chimney of the new two story house, and the current ran throughout the house's wiring and into one of the bedrooms. Most of the damage was to the roof and in the bedroom. Flying debris and brick knocked holes in the walls, and bricks from the chimney were found 105 feet away in a neighbor's yard.

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Wake Forest. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

Probability of Future Occurrences

Although there were not a high number of historical lightning events reported in Wake Forest via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S. National Lightning Detection Network (NLDN®), Wake Forest is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the jurisdiction.

J.2.6 Severe Thunderstorm/High Wind

Location and Spatial Extent

A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Also, Wake Forest typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Wake Forest has uniform exposure to an event and the spatial extent of an impact could be large.

Historical Occurrences

Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011.[5] According to NCDC, there have been 5 reported thunderstorm/high wind events since 1994 for high wind and since 1950 for thunderstorms.[6] These events caused $0 (2013 dollars) in damages. **Table J.12** summarizes this information. **Table J.13** presents detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event.[7]

TABLE J. 12: SUMMARY OF THUNDERSTORM/HIGH WIND OCCURRENCES IN WAKE FOREST

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Wake Forest	5	0/0	$0

Source: National Climatic Data Center

TABLE J.13: HISTORICAL THUNDERSTORM/HIGH WIND OCCURRENCES IN WAKE FOREST

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Wake Forest					
WAKE FOREST	1/19/1996	TSTM WIND	0 kts.	0/0	$0
WAKE	3/5/1997	TSTM WIND	50 kts.	0/0	$0

[5] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.

[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional thunderstorm events have occurred in Wake Forest. As additional local data becomes available, this hazard profile will be amended.

[7] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
FOREST/ZEBULON					
WAKE FOREST	8/14/1999	TSTM WIND	0 kts.	0/0	$0
WAKE FOREST	6/11/2004	TSTM WIND	50 kts.	0/0	$0
WAKE FOREST	7/1/2012	THUNDERSTORM WIND	50 kts.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire jurisdiction.

J.2.7 Tornado

Location and Spatial Extent

Tornadoes occur throughout the state of North Carolina, and thus in Wake Forest. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Wake Forest is uniformly exposed to this hazard.

Historical Occurrences

Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there have been no recorded tornado events in Wake Forest since 1956 (**Table J.14**), resulting in $0 (2013 dollars) in property damages.[8] Detailed information on these events can be found in **Table J.15**. Although no events were reported, an F5 event is possible. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is likely that a high number of occurrences have gone unreported over the past 50 years.

TABLE J.14: SUMMARY OF TORNADO OCCURRENCES IN WAKE FOREST

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Wake Forest	0	0/0	$0

Source: National Climatic Data Center

TABLE J.15: HISTORICAL TORNADO IMPACTS IN WAKE FOREST

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Wake Forest					
None reported					

[8] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Wake Forest. As additional local data becomes available, this hazard profile will be amended.

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details

*Property Damage is reported in 2013 dollars.
Source: NCDC

2011 Tornadoes- April 16, 2011
In 2011, the county and all of its jurisdictions were impacted by one of the worst tornado-related events in the county's recorded history. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries.

Probability of Future Occurrences
According to historical information, tornado events are not an annual occurrence for the jurisdiction. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Wake Forest experience a direct tornado strike. The probability of future tornado occurrences affecting Wake Forest is likely (10-100 percent annual probability).

J.2.8 Winter Storm and Freeze

Location and Spatial Extent
Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Wake Forest is accustomed to smaller scale severe winter weather conditions and often receives severe winter weather during the winter months. Given the atmospheric nature of the hazard, the entire jurisdiction has uniform exposure to a winter storm.

Historical Occurrences
Severe winter weather has resulted in six disaster declarations in Wake Forest. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. [9] According to the National Climatic Data Center, there have been no recorded winter storm events in Wake Forest since 1993 (**Table J.16**).[10] These events resulted in $0 (2013 dollars) in damages. However, there have been 28 recorded countywide events and most severe winter weather events are only recorded at the county level.

TABLE J.16: SUMMARY OF WINTER STORM EVENTS IN WAKE FOREST

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Wake Forest	0	0/0	$0

Source: National Climatic Data Center

[9] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[10] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional winter storm conditions have affected Wake Forest.

There have been several severe winter weather events in Wake Forest. The text below describes one of the major events and associated impacts on the county. Similar impacted can be expected with severe winter weather.

1996 Winter Storm
This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

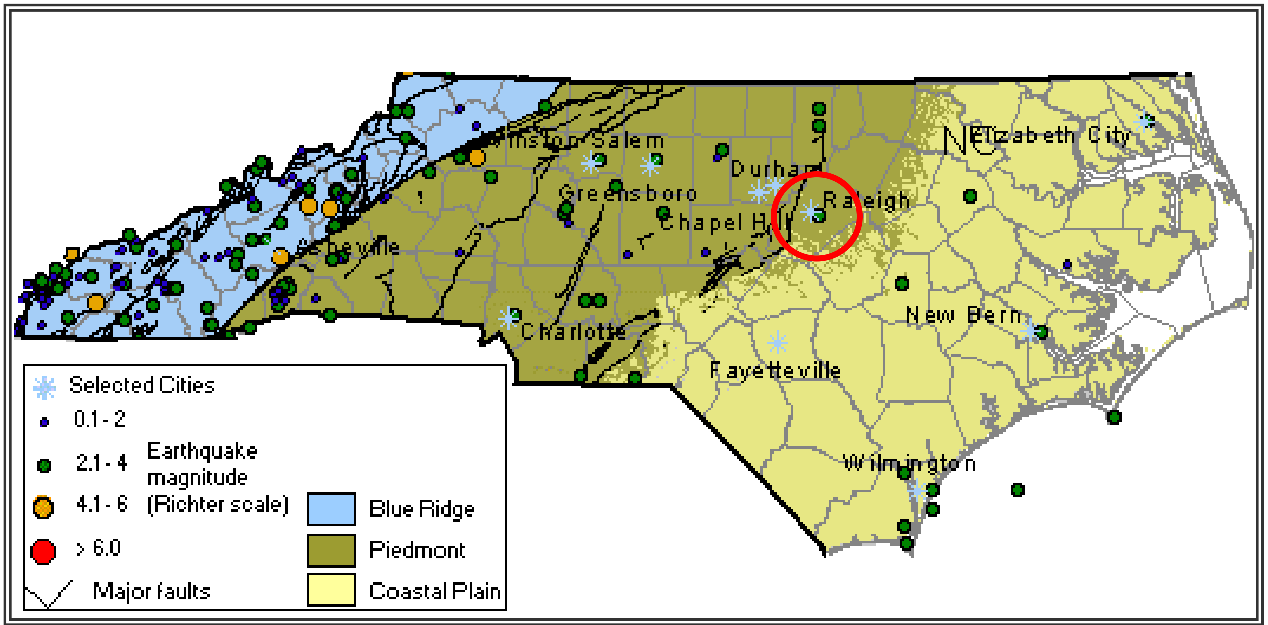
Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and power outages. Furthermore, citizens may resort to using inappropriate heating devices that could to fire or an accumulation of toxic fumes.

Probability of Future Occurrences
Winter storm events will remain a somewhat regular occurrence in Wake Forest due to location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

J.2.9 Earthquake

Location and Spatial Extent
Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina. **Figure J.2** is a map showing geological and seismic information for North Carolina.

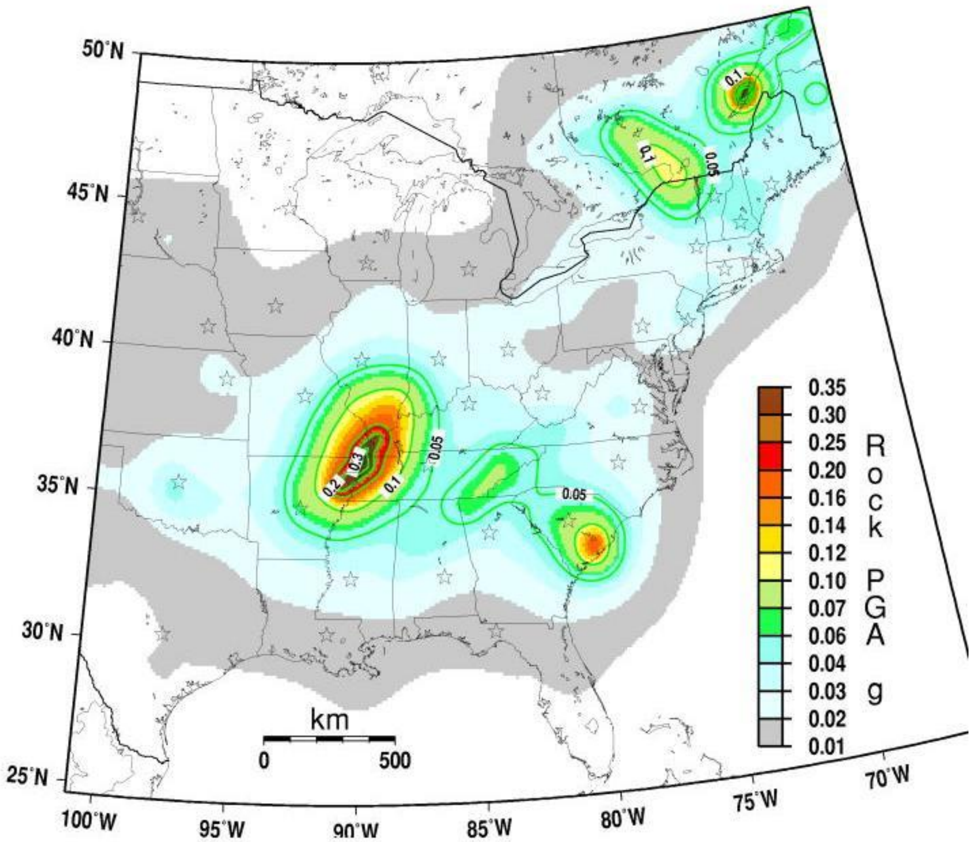
FIGURE J.2: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure J.3 shows the intensity level associated with Wake Forest, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Wake Forest lies within an approximate zone of level "2" to "3" ground acceleration. This indicates that the county exists within an area of moderate seismic risk.

FIGURE J.3: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

Historical Occurrences

Although no earthquakes are known to have occurred directly in Wake Forest since 1874, several have occurred in the county and affected the municipality. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table J.17** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table J.18** presents a detailed occurrence of each event including the date, distance for the epicenter, and Modified Mercalli Intensity (if known).[11]

TABLE J.17: SUMMARY OF SEISMIC ACTIVITY IN WAKE FOREST

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Wake Forest	--	--	--

Source: National Geophysical Data Center

[11] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

TABLE J.18: SIGNIFICANT SEISMIC EVENTS IN WAKE FOREST (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI (magnitude)
Wake Forest				
None reported				

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Wake Forest, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table J.19.**

TABLE J.19: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 - 1	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928*	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957*	Buncombe County, NC	3.7	VI	VI
11/24/1957*	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973*	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Wake Forest occurrences.
** Conflicting reports on this event, intensity in North Carolina could have been either V or VI
Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Wake Forest is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. The annual probability level for the county is estimated between 1 and 10 percent (possible).

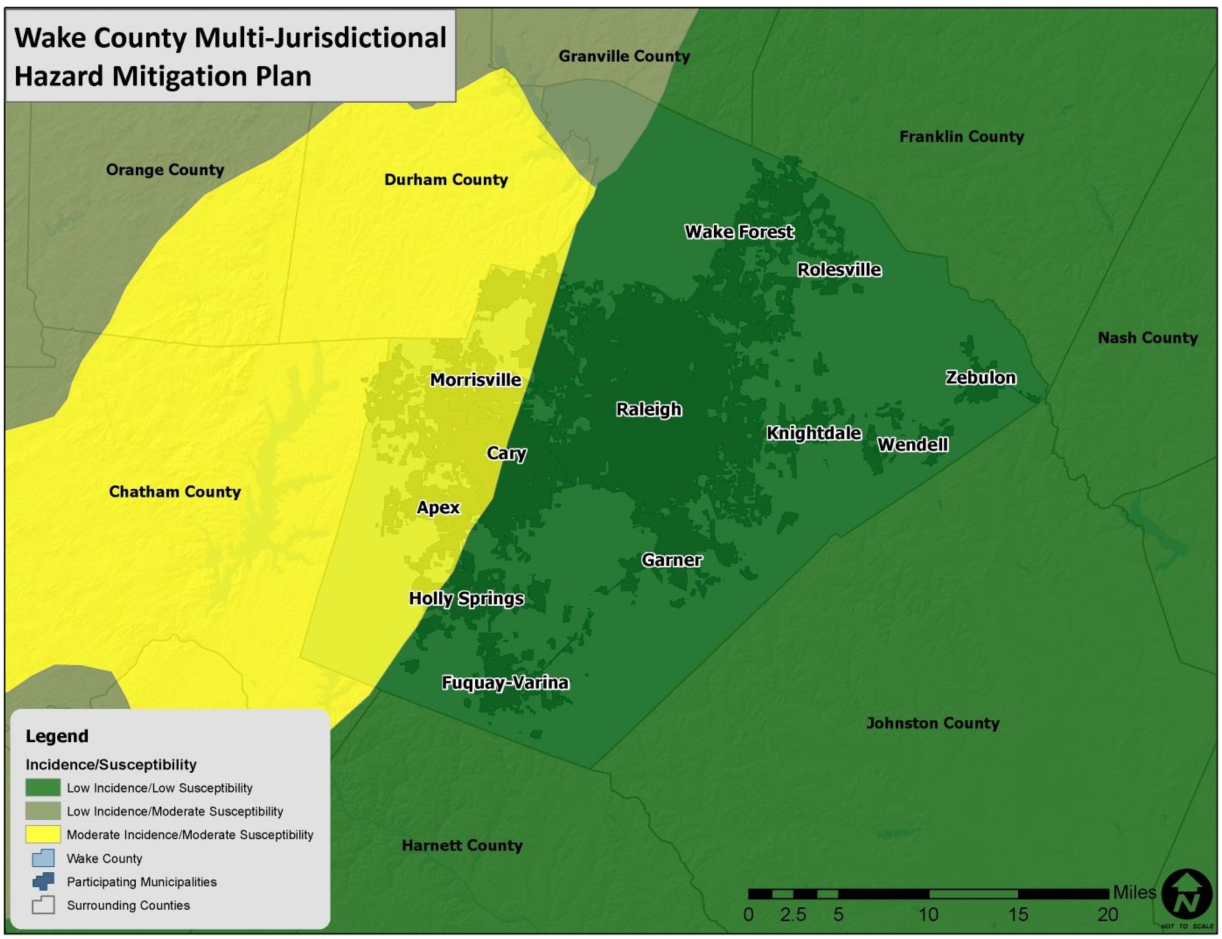
J.2.10 Landslide

Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Wake Forest, although the overall risk is relatively low.

According to **Figure J.4** below, the majority of the county has low landslide activity. However there is a small area along the western border of the county that has a moderate incidence and moderate susceptibility. In all other areas (including all of Wake Forest), there is low susceptibility.

FIGURE J.4: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

Historical Occurrences

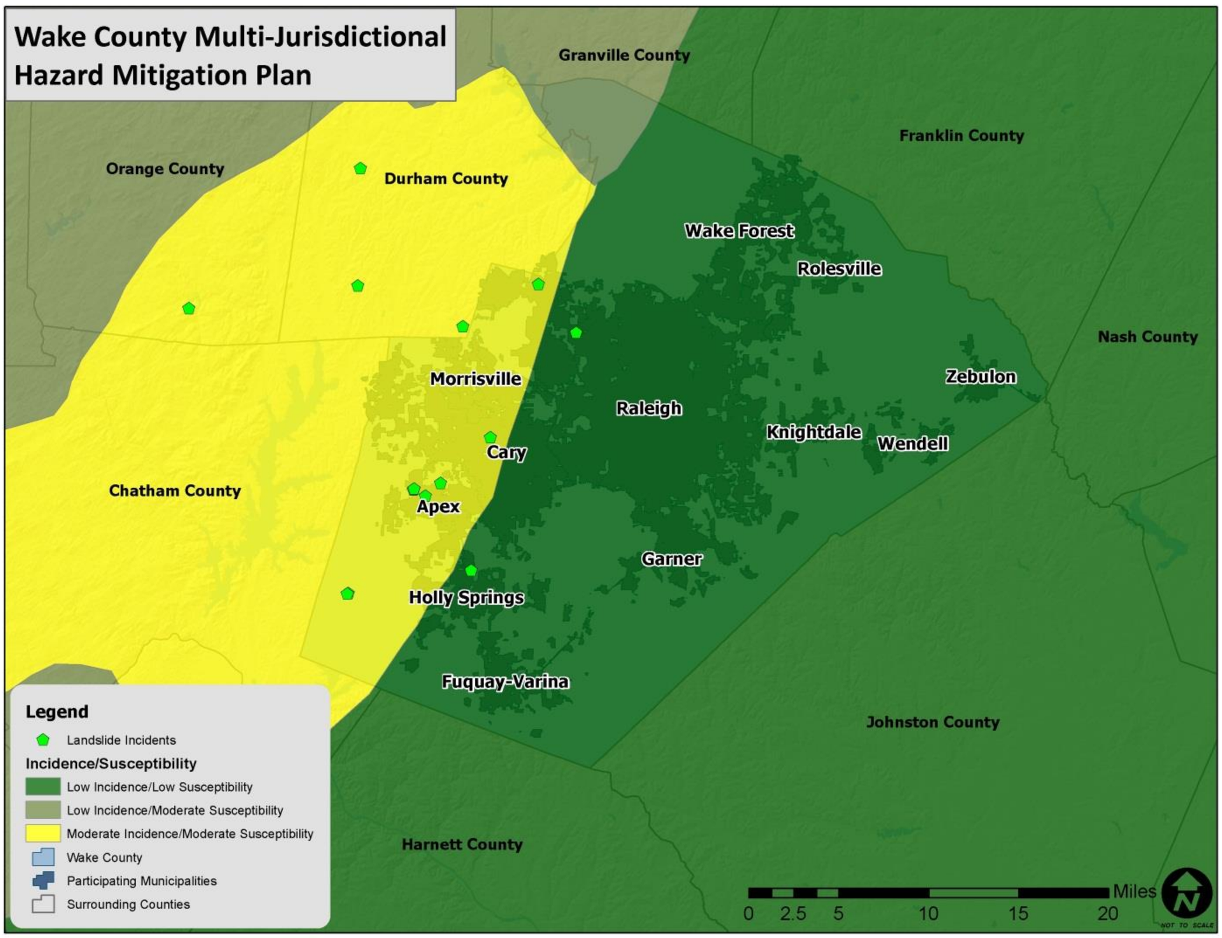
Steeper topography in some areas of Wake Forest make the planning area susceptible to landslides. Most landslides are caused by heavy rainfall in the area. Building on steep slopes that was not previously possible also contributes to risk. **Table J.20** presents a summary of the landslide occurrence events as provided by the North Carolina Geological Survey[12]. The georeferenced locations of the landslide events presented in the aforementioned tables are presented in **Figure J.5**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred in Wake Forest.

TABLE J.20: SUMMARY OF LANDSLIDE ACTIVITY IN WAKE FOREST

Location	Number of Occurrences
Wake Forest	0

Source: North Carolina Geological Survey

FIGURE J.5: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for

[12] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Wake Forest have greater risk than others given factors such as steepness on slope and modification of slopes.

J.2.11 Dam and Levee Failure

Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table J.21** explains these classifications.

TABLE J.21: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

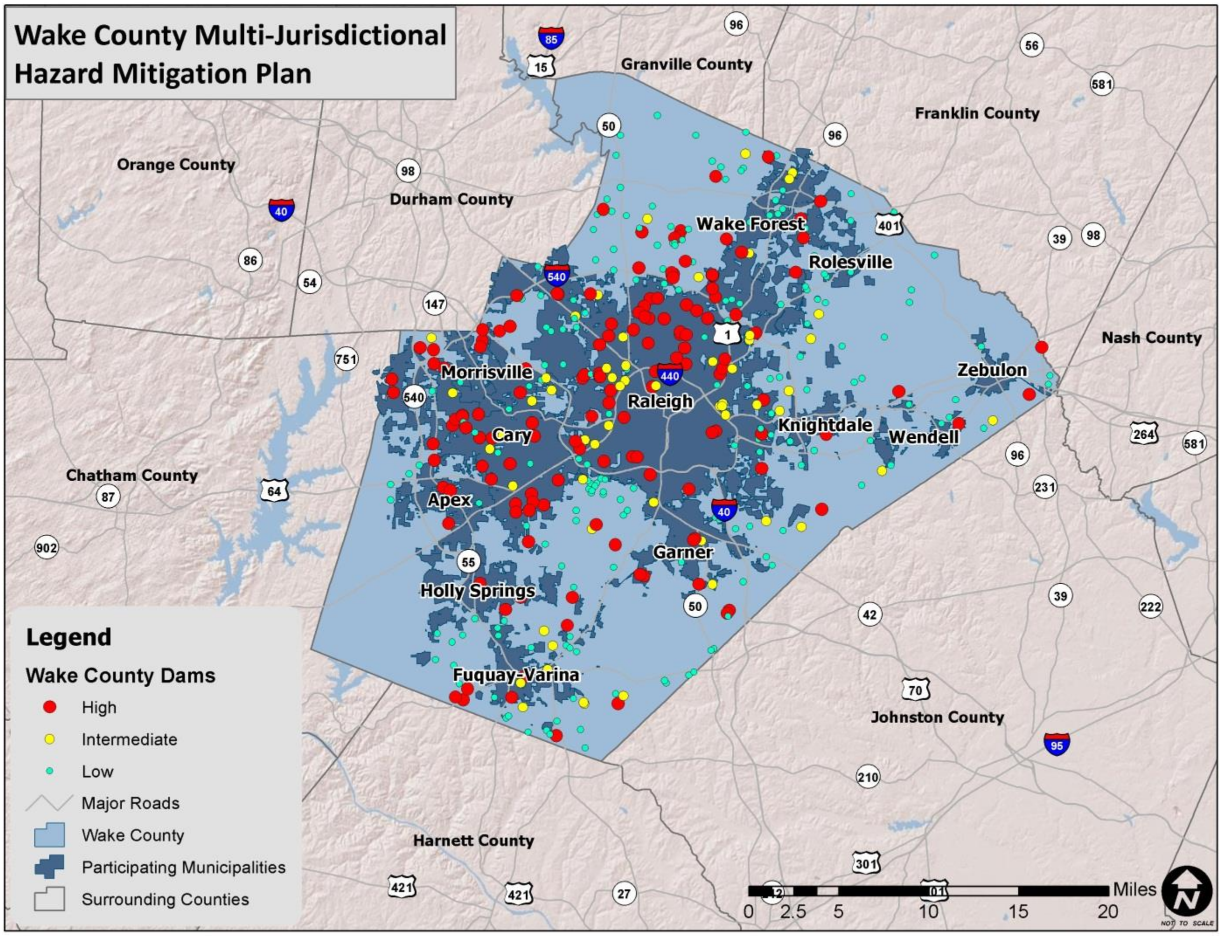
Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

According to the North Carolina Division of Land Management there are 11 dams in Wake Forest.[13] **Figure J.6** shows the dam location and the corresponding hazard ranking for each. Of these dams, three are classified as high hazard potential. These high hazard dams are listed in **Table J.22**.

[13] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE J.6: WAKE COUNTY DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE J.22: WAKE FOREST HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Wake Forest				
Wake Forest Water Supply Dam	High	50	945	Local Gov
Lewis Dam	High	10	80	Private
St. Andrews Plantation Dam	High	3	23	Private

Source: North Carolina Division of Land Resources, 2012

It should also be noted that the North Carolina dam classification regulations were recently updated. As a result of the change, more dams are generally classified as high hazard.

Historical Occurrences

No dam breaches were reported in Wake Forest. However, several breach scenarios in the jurisdiction could cause substantial damage.

Probability of Future Occurrences

Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

J.2.12 Erosion

Location and Spatial Extent

Erosion in Wake Forest is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Wake Forest soils have greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Wake Forest, particularly along the banks of rivers and streams, but it is not an extreme threat. No areas of concern were reported by the planning committee.

Historical Occurrences

Several sources were vetted to identify areas of erosion in Wake Forest. This includes searching local newspapers, interviewing local officials, and reviewing the previous hazard mitigation plan. Little information could be found and erosion was not addressed in the previous Wake Forest hazard mitigation plan.

Probability of Future Occurrences

Erosion remains a natural, dynamic, and continuous process for Wake Forest, and it will continue to occur. The annual probability level assigned for erosion is possible (between 1 and 10 percent annually).

J.2.13 Flood

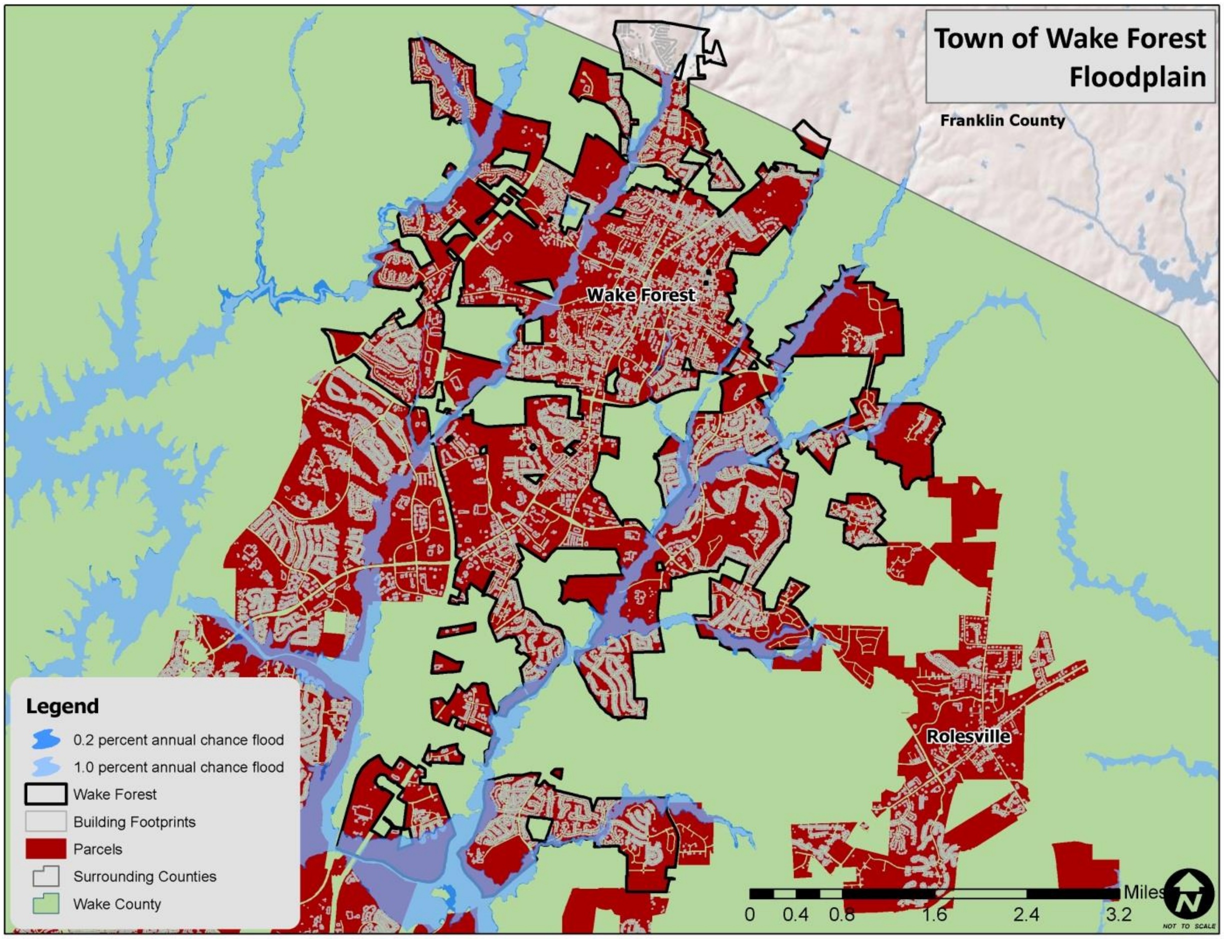
Location and Spatial Extent

There are areas in Wake Forest that are susceptible to flood events. Special flood hazard areas in the jurisdiction were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[14] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 14 square miles that make up Wake Forest, there are 1.56 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain).

These flood zone values account for 11.1 percent of the total land area in Wake Forest. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas. **Figure J.7** illustrates the location and extent of currently mapped special flood hazard areas for Wake Forest based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.

[14] The county-level DFIRM data used for Wake Forest were updated in 2010.

FIGURE J.7: SPECIAL FLOOD HAZARD AREAS IN WAKE FOREST



Source: Federal Emergency Management Agency

Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported a total of 3 events in Wake Forest since 1993.[15] A summary of these events is presented in **Table J.23**. These events accounted for over $0 (2013 dollars) in property damage in the county.[16] Specific information on flood events, including date, type of flooding, and deaths and injuries, can be found in **Table J.24**.

TABLE J.23: SUMMARY OF FLOOD OCCURRENCES IN WAKE FOREST

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Wake Forest	3	0/0	$0

Source: National Climatic Data Center

[15] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.
[16] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

TABLE J.24: HISTORICAL FLOOD EVENTS IN WAKE FOREST

	Date	Type	Deaths/ Injuries	Property Damage*
Wake Forest				
WAKE FOREST	8/26/1999	FLASH FLOOD	0/0	$0
WAKE FOREST	9/10/2001	FLASH FLOOD	0/0	$0
WAKE FOREST	12/2/2009	FLASH FLOOD	0/0	$0

Source: National Climatic Data Center

Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there have been 0 flood losses reported in Wake Forest through the National Flood Insurance Program (NFIP) since 1978. A summary of these figures for the jurisdiction is provided in **Table J.25**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that additional instances of flood loss in Wake Forest were either uninsured, denied claims payment, or not reported.

TABLE J.25: SUMMARY OF INSURED FLOOD LOSSES IN WAKE FOREST

Location	Flood Losses	Claims Payments
Wake Forest	0	$0

Source: FEMA, NFIP

Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

As of July 2013, there are 0 non-mitigated repetitive loss properties located in Wake Forest, which accounted for 0 losses and $0 in claims payments under the NFIP. Without mitigation, repetitive loss properties will likely continue to experience flood losses. **Table J.26** presents detailed information on repetitive loss properties and NFIP claims and policies for Wake Forest.

TABLE J.26: SUMMARY OF REPETITIVE LOSS PROPERTIES IN WAKE FOREST

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Wake Forest	0	-	0	$0	$0	$0	$0

Source: National Flood Insurance Program

Probability of Future Occurrences

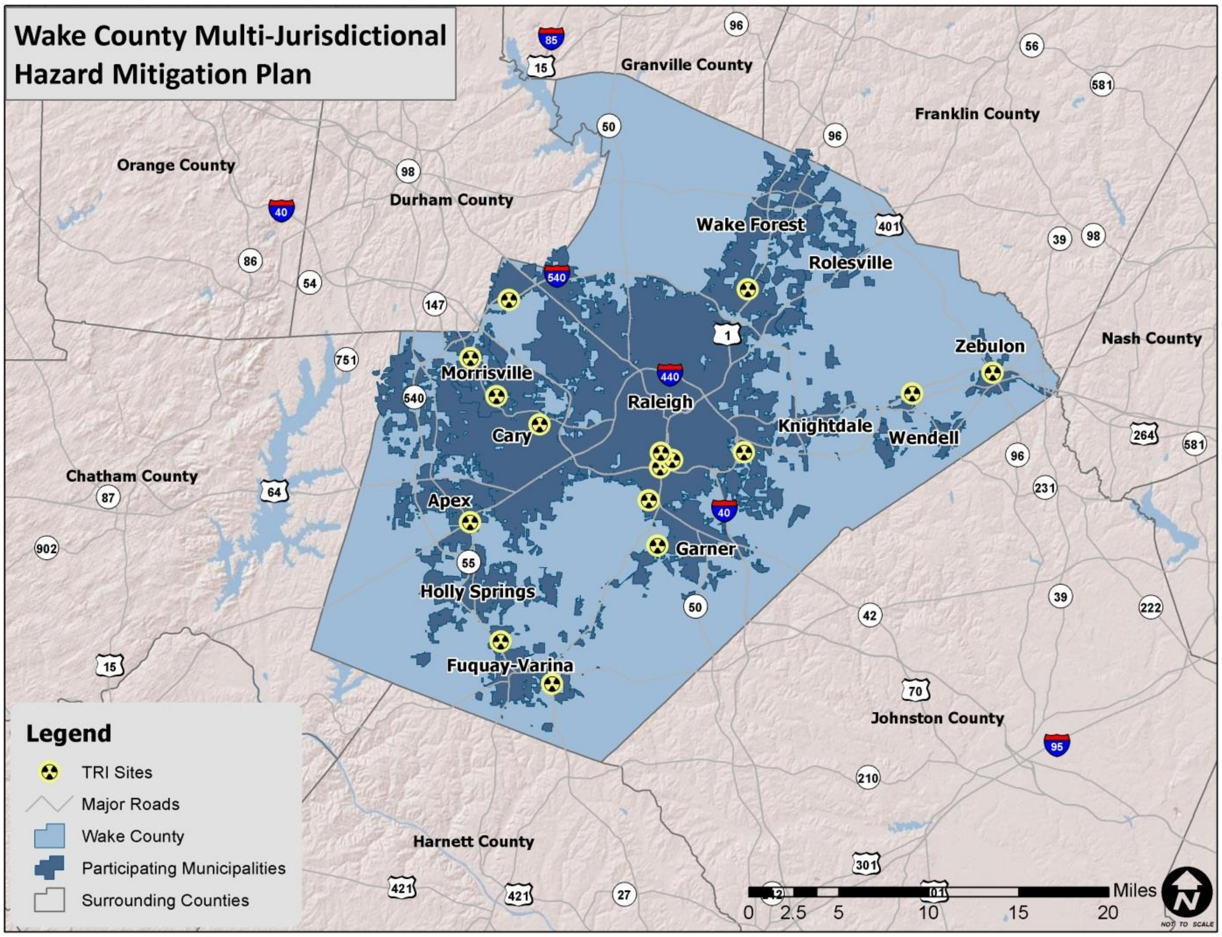
Flood events will remain a threat in areas prone to flooding in Wake Forest, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability) The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above**,** which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

J.2.14 Hazardous Materials Incidents

Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Wake Forest has no TRI sites as shown in **Figure J.8.**

FIGURE J.8: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the jurisdiction via roadways and rail. All roads that permit hazardous material transport are considered potentially at risk to an incident.

Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table J.27 presents detailed information on historic HAZMAT incidents reported in Wake Forest.

TABLE J.27: SUMMARY OF HAZMAT INCIDENTS IN WAKE FOREST

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Wake Forest							
None reported							

Source: USDOT PHMSA

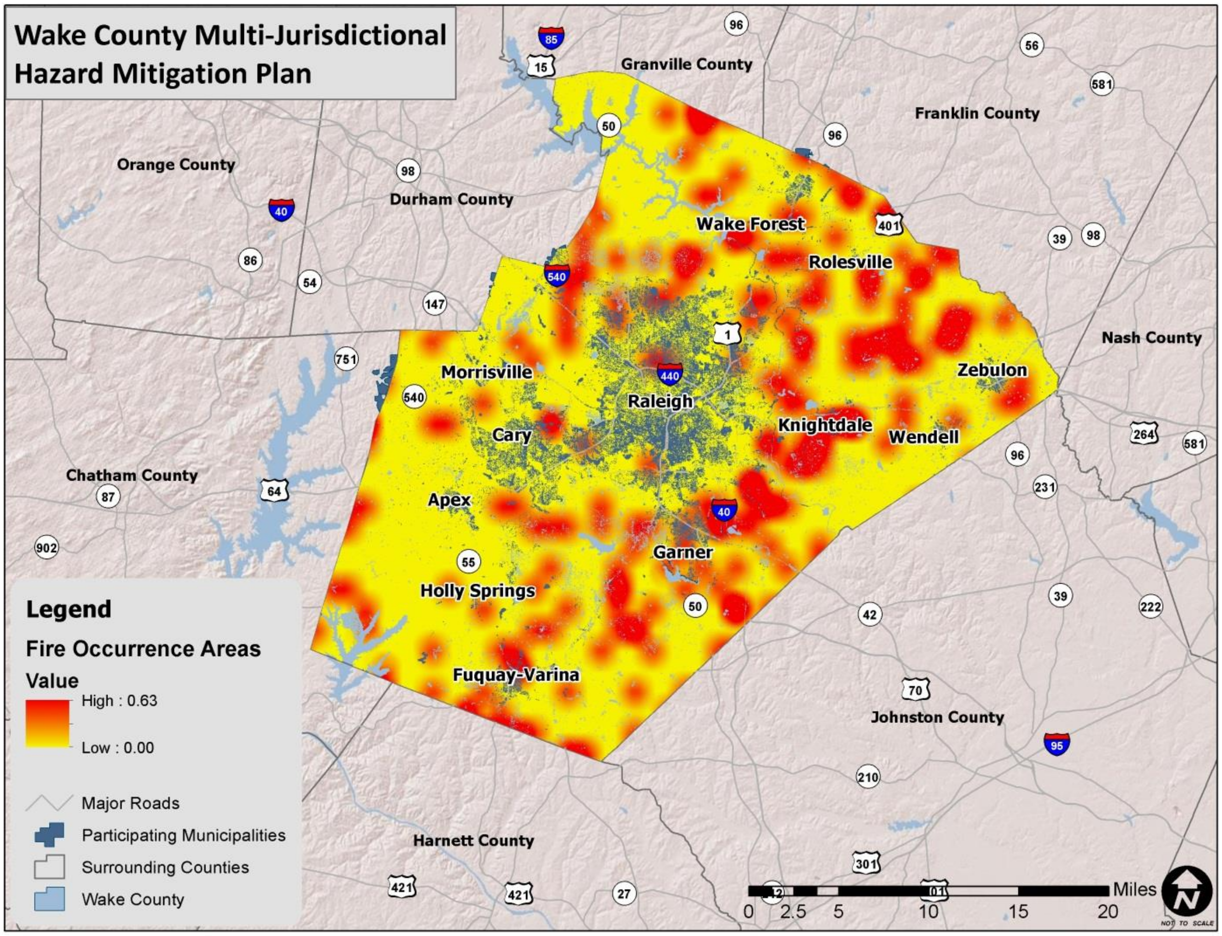
Probability of Future Occurrences
Although there are no toxic release inventory sites in Wake Forest, there are several roadways and rails that transport hazardous materials, so it is possible that a hazardous material incident may occur in the jurisdiction (between 1 percent and 10 percent annual probability). Local officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

J.2.15 Wildfire

Location and Spatial Extent
The entire jurisdiction is at some risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas.

Historical Occurrences
Figure J.9 shows the Fire Occurrence Areas (FOA) in Wake Forest based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. Therefore, even areas classified as at relatively high risk within the county are a relatively low risk compared to other areas of the state.

FIGURE J.9: HISTORIC WILDFIRE EVENTS IN WAKE FOREST



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of 16 wildfires annually which burn an average of 98 acres per year. The data indicates that most of these fires are small, averaging six acres per fire. **Table J.28** lists the number of reported wildfire occurrences in the county between the years 2003 and 2012.

TABLE J.28: HISTORICAL WILDFIRE OCCURRENCES IN WAKE FOREST

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Wake Forest. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Wake Forest for future wildfire events is possible (a 1 and 10 percent annual probability).

J.2.16 Nuclear Accident

Location and Spatial Extent

The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station.

Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 “Alerts” and 28 “Notice of Unusual Events” since 1986, which are shown in **Table J.29**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table J.29: SHEARON HARRIS EMERGENCY DECLARATION HISTORY

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on “B” Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).

Emergency Declaration	Date	Description
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of “A” Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - “B” diesel generator was being worked on; in accordance with test procedures, “A” diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported “Notice of Unusual Events” since 1986, which is shown in **Table J.30**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table J.30: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Probability of Future Occurrences
A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

J.2.17 Terror Threat

Location and Spatial Extent
A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table J.31** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

TABLE J.31 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food ▪ Banking and Finance ▪ Chemical ▪ Commercial Facilities ▪ Communications ▪ Critical Manufacturing ▪ Dams ▪ Defense Industrial Base ▪ Emergency Services ▪ Energy	▪ Government Facilities ▪ Healthcare and Public Health ▪ Information Technology ▪ National Monuments and Icons ▪ Nuclear Reactors, Materials, and Waste ▪ Postal and Shipping ▪ Transportation Systems ▪ Water

Historical Occurrences
Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

Probability of Future Occurrences
Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

J.2.18 Conclusions on Hazard Risk

The hazard profiles presented above were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and

experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

Hazard Extent

Table J.32 describes the extent of each natural hazard identified for Wake Forest. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE J.32 EXTENT OF WAKE FOREST HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page J:4). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Wake Forest has received this ranking three times over the fourteen year reporting period.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Wake Forest was 1.75 inches. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), Wake Forest is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Thunderstorm Wind/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Wake Forest was reported at 50 knots (approximately 58 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). Although there were no tornado events reported, a F5 is possible.
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Wake Forest. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is low in Wake Forest.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). Of the 11 dams in Wake Forest, 3 are classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records located in Wake Forest.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 2.0 percent of the total land area in Wake Forest. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second.
Other Hazards	
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incident reported in the region is 75 LGA released on the highway in Raleigh. It should be noted that larger events are possible.
Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).

Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

Priority Risk Index Results

In order to draw some meaningful planning conclusions on hazard risk for Wake Forest, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). More information on the PRI and how it was calculated can be found in Section 5.20.2.

Table J.33 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups and Coordinating Committee. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE J.33: SUMMARY OF PRI RESULTS FOR WAKE FOREST

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	**2.5**
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	**2.4**
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	**2.5**
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	**2.1**
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	**3.1**
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.7**
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	**2.5**
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2**
Landslide	Unlikely	Minor	Small	Less than 6 hours	Less than 6 hours	**1.5**
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	**1.8**
Flood	Likely	Critical	Moderate	6 to 12 hours	Less than 1 week	**3**
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	**2**
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	**2.6**
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	**2.4**

J.2.16 Final Determinations on Hazard Risk

The conclusions drawn from the hazard profiling process for Wake Forest, including the PRI results and input from the Regional Work Groups and Coordinating Committee, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table J.34**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Wake Forest. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment* and below in Section J.3. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE J.34: CONCLUSIONS ON HAZARD RISK FOR WAKE FOREST

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Nuclear Accident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

J.3 TOWN OF WAKE FOREST VULNERABILITY ASSESSMENT

This subsection identifies and quantifies the vulnerability of Wake Forest to the significant hazards previously identified. This includes identifying and characterizing an inventory of assets in the county and assessing the potential impact and expected amount of damages caused to these assets by each identified hazard event. More information on the methodology and data sources used to conduct this assessment can be found in Section 6: *Vulnerability Assessment*.

J.3.1 Asset Inventory

Table J.35 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for Wake Forest (study area of vulnerability assessment).[17]

TABLE J.35: IMPROVED PROPERTY IN WAKE FOREST

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Wake Forest	12,035	$3,802,436,656	11,476	$2,819,911,530

Table J.36 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in Wake Forest. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. In addition, a list of secondary facilities was created to recognize the importance of these facilities in the event of a disaster. These facilities were not mapped, but it is important to recognize that they could be potentially impacted by nearly any of the identified hazards, especially those that are atmospheric or have no specific spatial delineation.

All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure J.10** shows the locations of the primary critical facilities in Wake County. **Table J.48**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility. As noted previously, this list is not all-inclusive and only includes information provided by the local government.

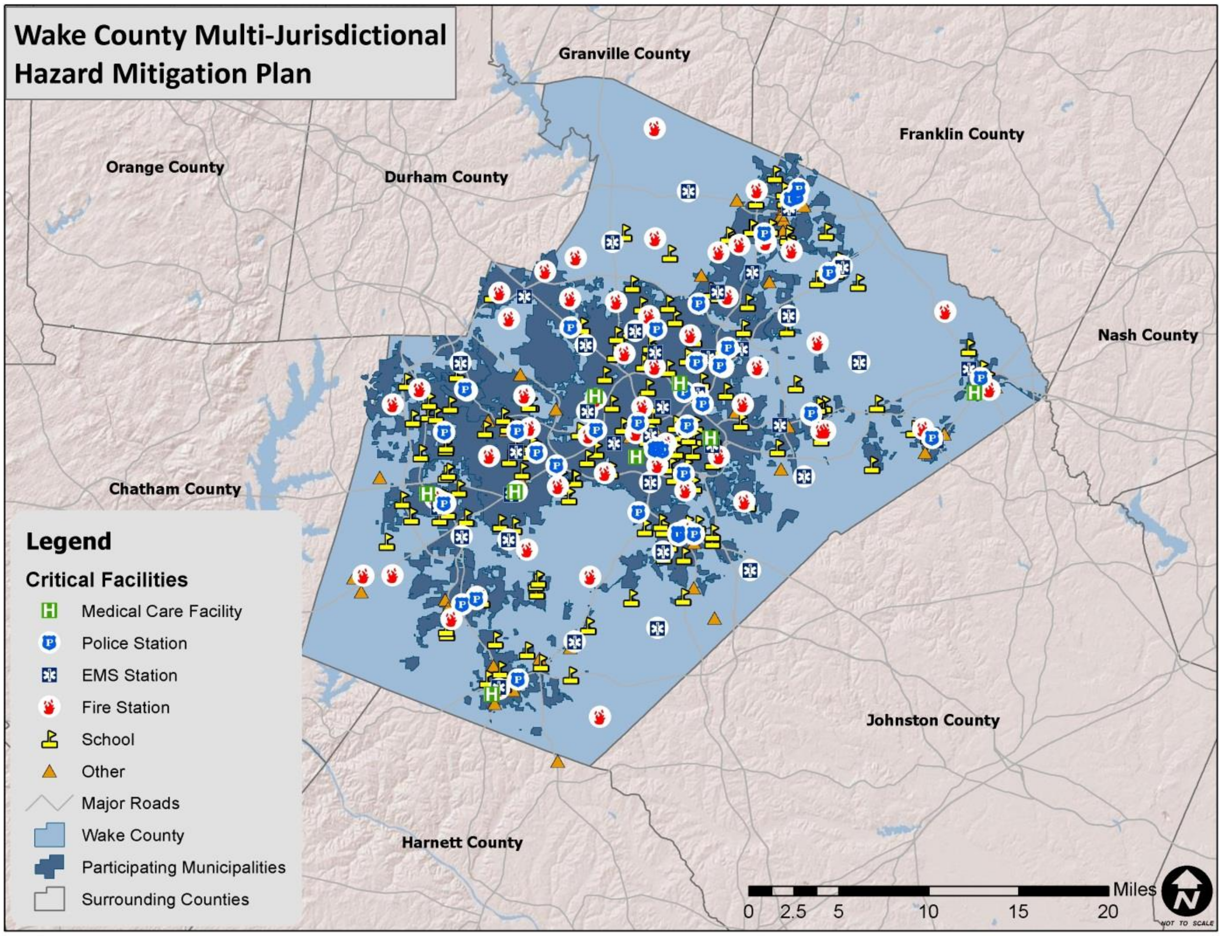
TABLE J.36: CRITICAL FACILITY INVENTORY IN WAKE FOREST

Location	Fire Stations	Police Stations	EMS Stations	Medical Care Facilities	Schools	Other
Wake Forest	4	4	2	0	8	9

Source: Local Governments

[17] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

FIGURE J.10: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: Local Governments

J.3.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Wake Forest that are potentially at risk to these hazards.

Table J.37 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, limited the results to county-wide estimates. The total population in Wake Forest according to Census data is 30,117 persons. Additional population estimates are presented above in Section J.1.

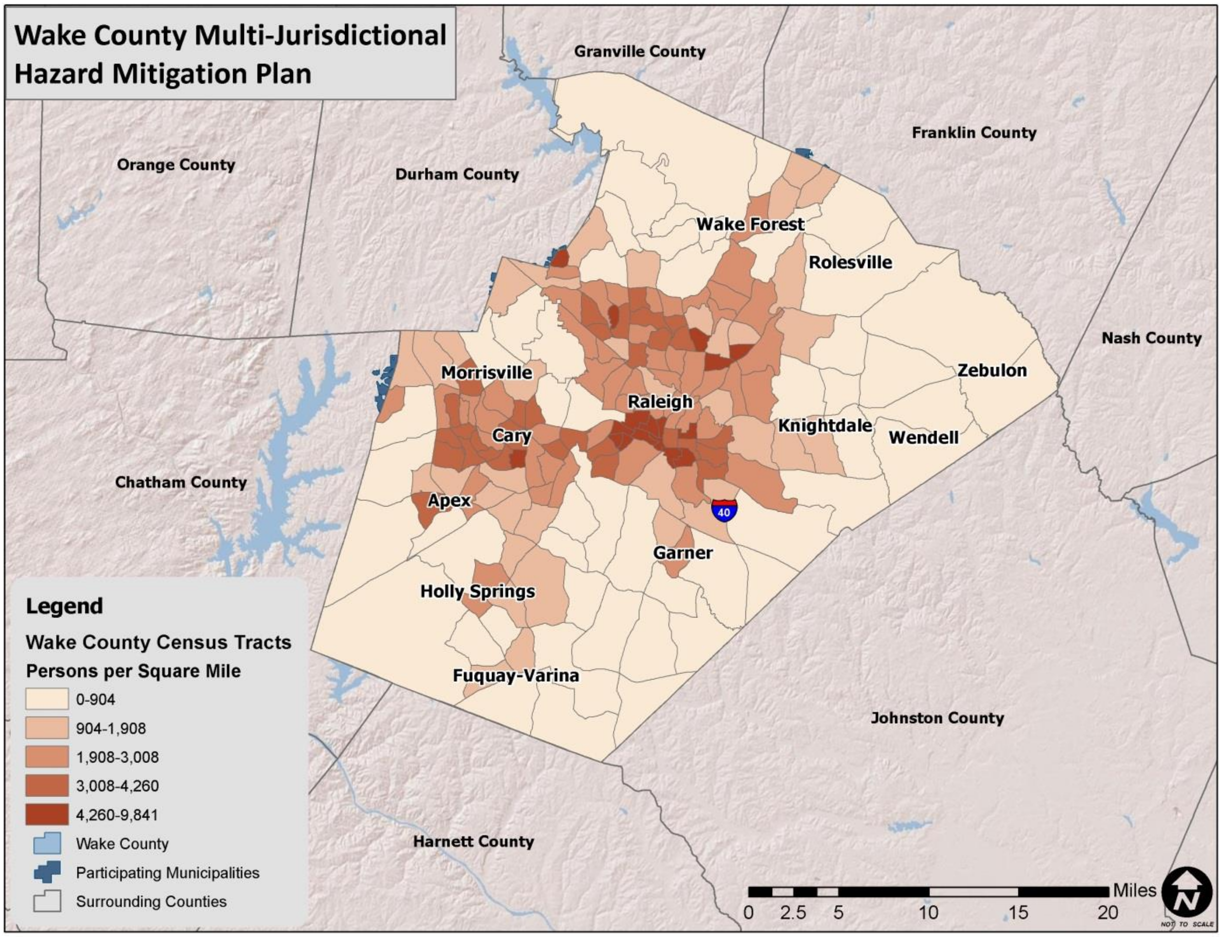
TABLE J.37: TOTAL POPULATION IN WAKE FOREST

Location	Total 2010 Population
Wake Forest	30,117

Source: U.S. Census 2010

In addition, **Figure J.11** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[18]

FIGURE J.11: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

J.3.3 Vulnerability Assessment Results

As noted in Section 6: *Vulnerability Assessment*, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results, specific to Wake Forest, are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total county exposure, and thus risk, was presented in **Table J.35**.

The annualized loss estimate for all hazards is presented at the end of this section in **Table J.47.**

The hazards presented in this section include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

[18] Population by census block was not available at the time this plan was completed.

Hurricane and Tropical Storm

Historical evidence indicates that Wake Forest has a significant risk to the hurricane and tropical storm hazard. Several tracks have come near or traversed through the county, as shown and discussed in Section J.2.4.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes, and high winds and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table J.38.** Only losses to buildings are reported, in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE J.38: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table J.39.**

TABLE J.39: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Wake Forest	73.8	82.9	100.6	107.1

Source: Hazus-MH 2.1

Social Vulnerability

Given equal susceptibility across the county, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Wake Forest, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table J.48** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Wake Forest. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

Earthquake

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table J.40** summarizes the findings.

TABLE J.40: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability

It can be assumed that all existing future populations are at risk to the earthquake hazard.

Critical Facilities

The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table J.48**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Wake Forest. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

Landslide

In order to complete the vulnerability assessment for landslides in Wake Forest, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section J.2.10), tax parcel and building footprint data, and GIS analysis. **Table J.41** presents the potential at-risk property where available. All areas of Wake Forest are identified as low incidence areas by the USGS landslide data. Since there were no high incidence levels in the county, the moderate incidence level was used to identify different areas of concern for the analysis below.

TABLE J. 41: TOTAL POTENTIAL AT-RISK PARCELS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	**Moderate**		
Wake Forest	0	0	$0

Source: USGS

Social Vulnerability
Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides. However, Wake Forest is probably at somewhat higher risk than other jurisdictions.

Critical Facilities
No critical facilities are located in a moderate susceptibility area. A list of specific critical facilities and their associated risk can be found in **Table J.48** at the end of this section.

In conclusion, a landslide has the potential to impact existing and future buildings, facilities, and populations in Wake Forest, though some areas are at a higher risk than others due to a variety of factors. For example, steep slopes and modified slopes bear a greater risk than flat areas. Specific vulnerabilities for county assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

Flood
Historical evidence indicates that Wake Forest is susceptible to flood events. A total of 3 flood events have been reported by the National Climatic Data Center resulting in $0 in damages. On an annualized level, these damages amounted to $0 for Wake Forest.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for the county. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table J.42** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

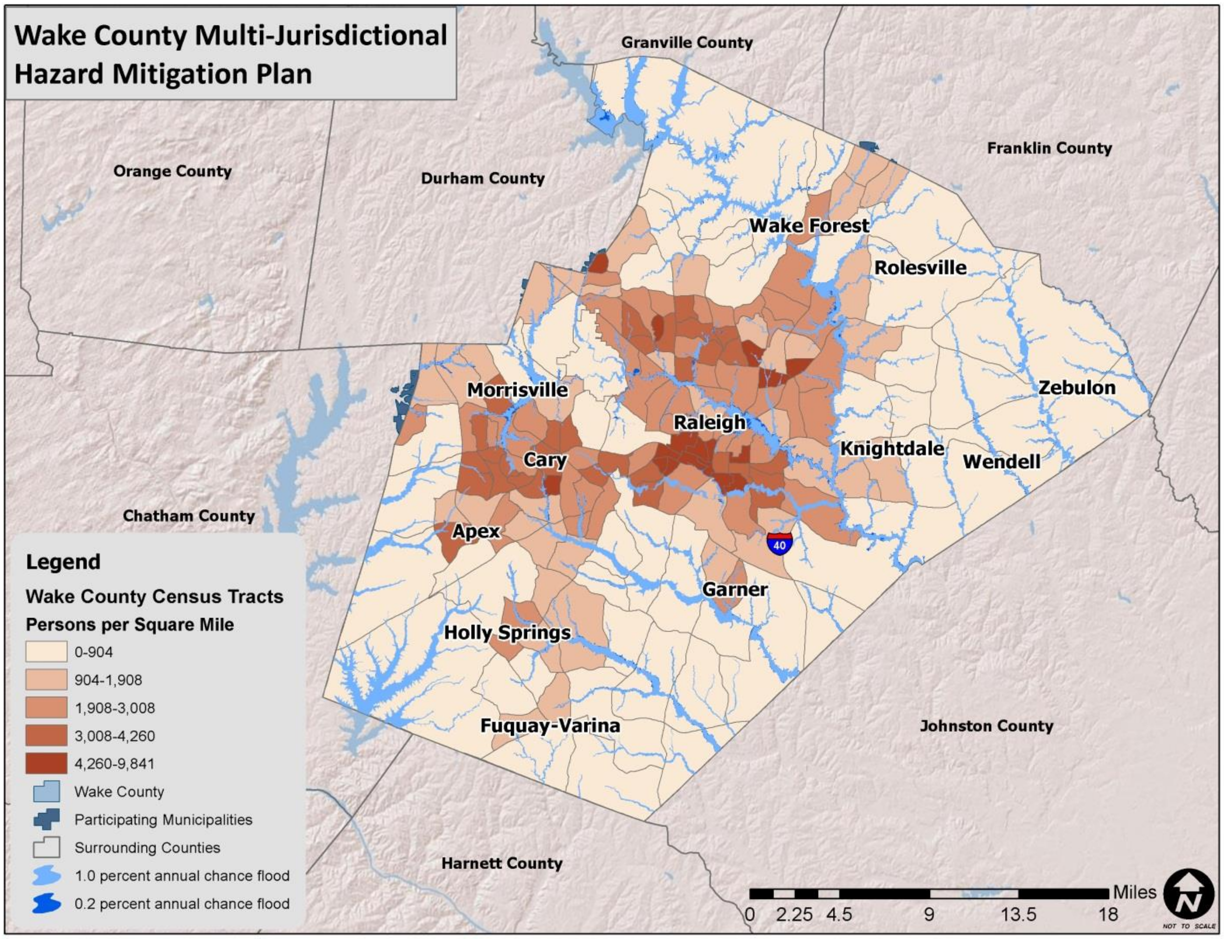
TABLE J.42: ESTIMATED EXPOSURE OF PARCELS TO THE FLOOD HAZARD

Location	1.0-percent ACF			0.2-percent ACF		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings
Wake Forest	789	201	$370,427,376	122	81	$31,659,382

Source: FEMA DFIRM

Social Vulnerability
Since 2010 population was available at the tract level, it was difficult to determine a reliable figure on population at-risk to flood due to tract level population data. **Figure J.12** is presented to gain a better understanding of at risk population.

FIGURE J.12 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities

The critical facility analysis revealed that there are a no critical facilities located in the Wake Forest 1.0-percent annual chance floodplain and 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. A list of specific critical facilities and their associated risk can be found in **Table J.48** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings and populations in Wake Forest, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

Hazardous Materials Incident

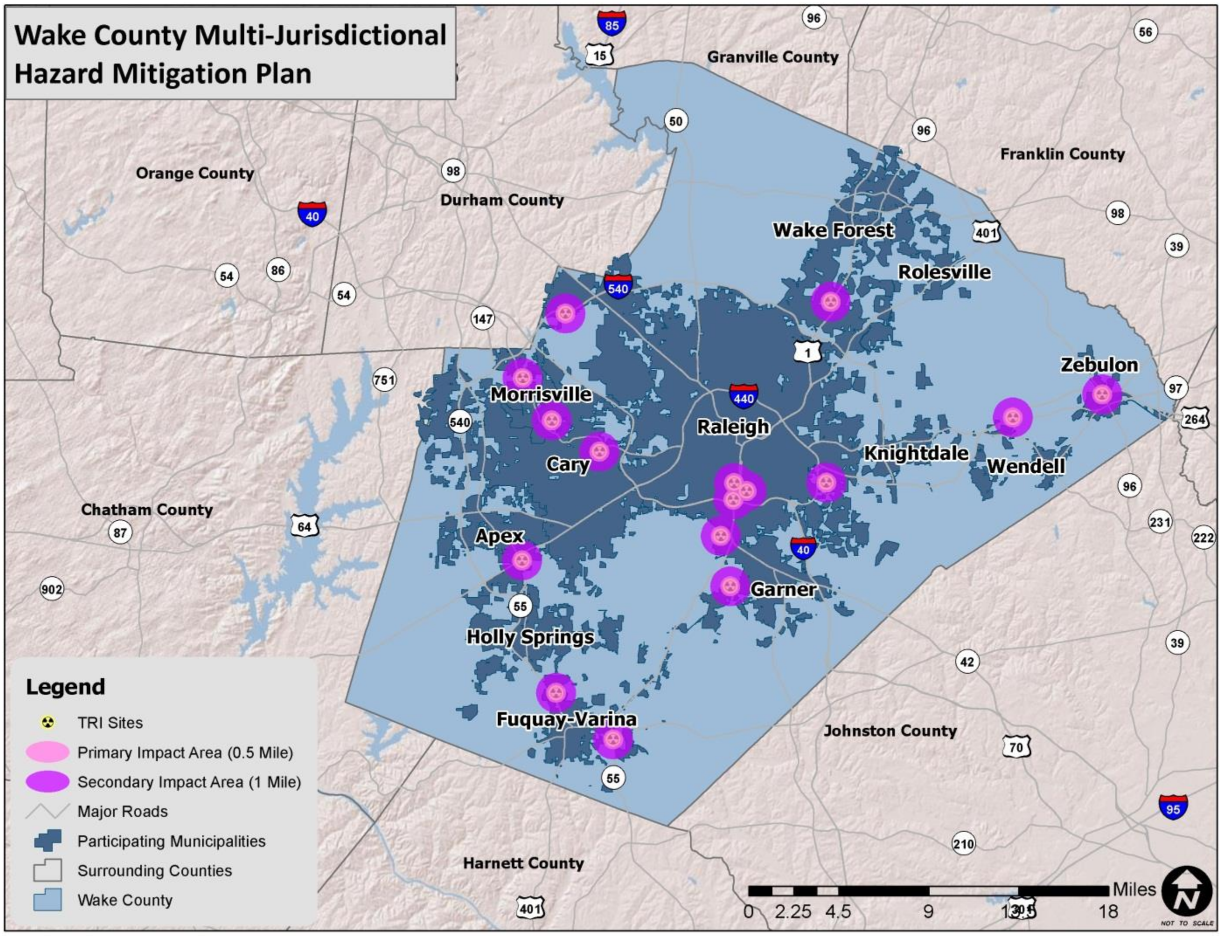
Although historical evidence and existing Toxic Release Inventory sites indicate that Wake Forest is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Wake Forest.

Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[19] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Wake Forest, along with buffers, were used for analysis as shown in **Figure J.13.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the GIS buffer analysis. **Figure J.14** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table J.43** (fixed sites), **Table J.44** (mobile road sites) and **Table J.45** (mobile railroad sites).[20]

[19] This type of analysis will likely yield inflated results (generally higher than what is actually reported after an event).
[20] Note that parcels included in the 1.0-mile analysis are also included in the 0.5-mile analysis.

FIGURE J.13 : TRI SITES WITH BUFFERS IN WAKE FOREST



Source: EPA

TABLE J.43: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Wake Forest	0	0	$0	4	11	$1,078,101

FIGURE J.14 : MOBILE HAZMAT BUFFERS IN WAKE FOREST

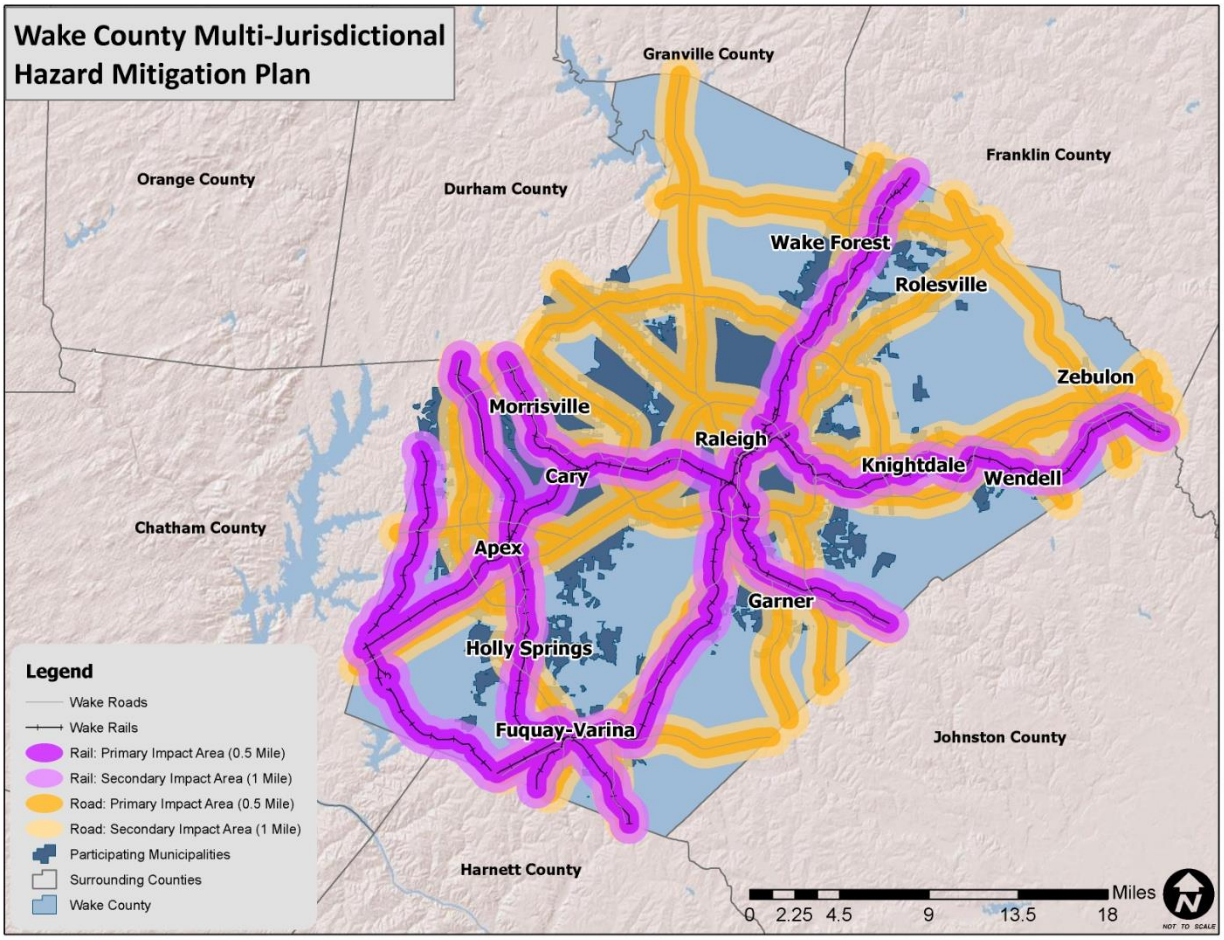


TABLE J.44: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Wake Forest	6,844	6,987	$1,445,105,064	9,208	9,345	$2,003,231,609

TABLE J.45: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Wake Forest	3,975	4,525	$803,998,355	6,645	6,942	$1,448,927,511

Social Vulnerability
Given high susceptibility across the jurisdiction, it is assumed that the total population is at risk to a hazardous materials incident. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities
Fixed Site Analysis:
The critical facility analysis for fixed TRI sites revealed that no critical facilities are located in a HAZMAT risk zone. A list of specific critical facilities and their associated risk can be found in **Table J.48** at the end of this section.

Mobile Analysis:
The critical facility analysis for road and railroad transportation corridors in Wake Forest revealed that there are 24 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 22 facilities. The remaining facilities are in the secondary, 1.0-mile zone. The railroad buffer areas include 21 facilities with 16 in the primary impact zone. It should be noted that many of the facilities located in the buffer areas for railroad are also located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table J.48** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Wake Forest. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc. Further, incidents from neighboring jurisdictions could also have an impact.

Wildfire
Although historical evidence indicates that Wake Forest is susceptible to wildfire events, there are few reports of damage. Upon conversion of the wildfire risk data (see Section 6: *Vulnerability Assessment*) and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the jurisdiction should be assumed to be very low. As such, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the county.

Social Vulnerability
All areas have relatively equal vulnerability and there is low susceptibility across the entire county. It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities
The critical facility analysis revealed that there are no critical facilities located in wildfire areas of concern. It should be noted, however, that several factors could impact the spread of a wildfire putting all facilities at risk. A list of specific critical facilities and their associated risk can be found in **Table J.48** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Wake Forest.

Nuclear Accident

The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table J.46** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE J.46: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[21]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[22]
Wake Forest	0	0	$0	12,035	11,476	$2,819,911,530

Social Vulnerability

Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in the 10-mile nuclear buffer area in Wake Forest.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in Wake Forest, though areas closer to the power plant are at a higher risk than others. All structures are at some risk given that they are all located within at least the 50-mile buffer area.

Conclusions on Hazard Vulnerability

Table J.47 presents a summary of annualized loss for each hazard in Wake Forest. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, although an annualized loss was determined through the damage reported through historical occurrences at the municipal level, it is likely that the county-wide

[21] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.

[22] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

estimate (found in Section 6: *Vulnerability Assessment*) is potentially a better estimate. These values should be used as an additional planning tool or measure risk for determining hazard mitigation strategies.

TABLE J.47: ANNUALIZED LOSS FOR WAKE FOREST*

Event	Wake Forest
Dam Failure	Negligible
Drought	Negligible
Erosion	Negligible
Extreme Heat	Negligible
Hail	Negligible
Hurricane & Tropical Storm	Negligible
Landslide	Negligible
Lightning	$3,723
Thunderstorm Wind/High Wind[23]	Negligible
Tornado	Negligible
Winter Storm & Freeze	Negligible
Flood	Negligible
Earthquake	Negligible
HAZMAT Incident	Negligible
Wildfire	Negligible
Nuclear Accident	Negligible
Terror Threat	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table J.48** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

[23] The annualized losses for these hazards were combined.

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TABLE J.48: AT-RISK CRITICAL FACILITIES IN WAKE FOREST

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
WAKE FOREST																								
WAKE FOREST	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST #2	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST #3	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
WAKE FOREST #4	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
WATER TREATMENT PLAN	OTHER	X	X	X	X	X	X	X	X	X							X	X					X	X
TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
SEWER TREATMENT PLANT	OTHER	X	X	X	X	X	X	X	X	X													X	X
PUBLIC WORKS OPERATIONS CENTER	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
CARILLON ASSISTED LIVING	OTHER	X	X	X	X	X	X	X	X	X								X	X	X			X	X
HILLSIDE NURSING CENTER	OTHER	X	X	X	X	X	X	X	X	X							X	X		X			X	X
CAROLINA HOUSE OF WAKE FOREST	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
THE LODGE (ELDERLY HOUSING)	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
TURNBERRY APARTMENTS (ELDERLY HOUSING)	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
MAIN	POLICE	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
	STATION																							
SUBSTATION TWO	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X		X			X	X
SUBSTATION THREE	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
SUBSTATION FOUR	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST MS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WAKE FOREST HS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
HERITAGE MS	SCHOOL	X	X	X	X	X	X	X	X	X								X		X			X	X
HERITAGE ES	SCHOOL	X	X	X	X	X	X	X	X	X								X		X			X	X
WAKEFIELD 9TH GRADE CENTER	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
RICHLAND CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
HERITAGE HS	SCHOOL	X	X	X	X	X	X	X	X	X										X			X	X

Secondary Critical Facilities are listed in slight contrast to Critical Facilities as their continued function has not been deemed as critical as primary facilities in the event of a disaster, but these facilities are extremely important. A loss of function to one of these facilities would have a definitively greater negative impact on the community's ability to respond to and recover from a disaster than a loss of function at other facilities/structures within the jurisdiction. In **Table J.49**, these facilities have been classified as either Significant Community Locations/Sheltering Centers or as Critical Resources Management Facilities. These facilities are all vulnerable to any of the atmospheric hazards and many are also likely vulnerable to other hazards identified above, though no locational analysis was carried out to this end.

TABLE J.49: WAKE FOREST SECONDARY CRITICAL FACILITIES

Facility Name	Address*	Type
Wake Forest		
Community House	133 West Owen Ave	Significant Community Location or Sheltering Center
Alston-Massenburg Recreation Center	416 Taylor St	Significant Community Location or Sheltering Center
Flaherty Park Center	North White Street	Significant Community Location or Sheltering Center
Electric Substation	West Cedar Ave	Critical Resources Management (Energy, Water, etc.)
Wake Forest Urgent Care		Significant Community Location or Sheltering Center
Fast Med		Significant Community Location or Sheltering Center
Public Service Company of NC		Critical Resources Management (Energy, Water, etc.)
Century Link Phone Service		Critical Resources Management (Energy, Water, etc.)
Wake Forest Power		Critical Resources Management (Energy, Water, etc.)
Duke Energy		Critical Resources Management (Energy, Water, etc.)
Wake Electric Membership Corporation		Critical Resources Management (Energy, Water, etc.)
Holding Oil Company		Critical Resources Management (Energy, Water, etc.)
Cruziers		Critical Resources Management (Energy, Water, etc.)
The Learning Experience		Significant Community Location or Sheltering Center
Wake Forest Child Care Center		Significant Community Location or Sheltering Center
Children's Adventure		Significant Community Location or Sheltering Center
Primrose School of Heritage		Significant Community Location or Sheltering Center
Goddard School		Significant Community Location or Sheltering Center
Wake Forest Kids-R-Kids		Significant Community Location or Sheltering Center
Kids Educational Center		Significant Community Location or Sheltering Center
Heritage Children's Academy		Significant Community Location or Sheltering Center
Rising Star Christian Academy		Significant Community Location or Sheltering Center
Wake Forest Baptist Church		Significant Community Location or Sheltering Center
St. John's Episcopal Church		Significant Community Location or Sheltering Center
Hope Lutheran Church		Significant Community Location or Sheltering Center
Wake Forest Presbyterian Church		Significant Community Location or Sheltering Center
St. Catherine of Siena Early Childhood Center		Significant Community Location or Sheltering Center

Facility Name	Address*	Type
Thales Academy		Significant Community Location or Sheltering Center
Endeavor Charter School		Significant Community Location or Sheltering Center
Wake Forest Charter Academy		Significant Community Location or Sheltering Center
Franklin Academy		Significant Community Location or Sheltering Center
St. Catherine's School		Significant Community Location or Sheltering Center
Southeastern Baptist Seminary		Significant Community Location or Sheltering Center
Dubois Center		Significant Community Location or Sheltering Center
Boys and Girls Club		Significant Community Location or Sheltering Center
US Post Office		Significant Community Location or Sheltering Center
Wake Forest Library		Significant Community Location or Sheltering Center
Wakefields		Significant Community Location or Sheltering Center
Glen Royall Apartments		Significant Community Location or Sheltering Center
Calvin Jones House		Significant Community Location or Sheltering Center
I.O. Jones House		Significant Community Location or Sheltering Center
Forestville Baptist Church		Significant Community Location or Sheltering Center
Oak Forest		Significant Community Location or Sheltering Center
Hartsfield House		Significant Community Location or Sheltering Center
Purefoy-Dunn House		Significant Community Location or Sheltering Center
Crenshaw Hall		Significant Community Location or Sheltering Center
Community House		Significant Community Location or Sheltering Center
Purefoy-Chappell House		Significant Community Location or Sheltering Center
Powell House		Significant Community Location or Sheltering Center

**Some address information could not be provided or was not applicable to the facility*

J.4 TOWN OF WAKE FOREST CAPABILITY ASSESSMENT

This subsection discusses the capability of the Town of Wake Forest to implement hazard mitigation activities. More information on the purpose and methodology used to conduct the assessment can be found in Section 7: *Capability Assessment*.

J.4.1 Planning and Regulatory Capability

Table J.50 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the Town of Wake Forest. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE J.50: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning Tool/Regulatory Tool	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan (Parks & Rec/Greenway Plan	Stormwater Management Plan/Ordinance	Natural Resource Protection Plan	Flood Response Plan	Emergency Operations Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	National Flood Insurance Program (NFIP)	NFIP Community Rating System
Wake Forest	✓	✓		✓	✓			✓				✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	

A more detailed discussion on the town's planning and regulatory capabilities follows.

Emergency Management

Hazard Mitigation Plan
The Town of Wake Forest has previously adopted a hazard mitigation plan.

Emergency Operations Plan
The Town of Wake Forest has adopted the Wake County Emergency Operations Plan. The town also maintains a municipal-level emergency operations plan.

General Planning

Comprehensive Land Use Plan
The Town of Wake Forest has adopted the *Wake Forest Community Plan*.

Capital Improvements Plan
The Town of Wake Forest has a five-year capital improvement plan in place.

Historic Preservation Plan
The Town of Wake Forest has adopted a historic preservation plan.

Zoning Ordinance
The Town of Wake Forest includes zoning regulations as part of the local unified development ordinance.

Subdivision Ordinance
The Town of Wake Forest also includes subdivision regulations as part of the local unified development ordinance.

Building Codes, Permitting, and Inspections
North Carolina has a state compulsory building code which applies throughout the state. The building code is enforced within the town's planning jurisdiction by the Town of Wake Forest Inspections Department.

Floodplain Management

Table J.51 provides NFIP policy and claim information for the Town of Wake Forest.

TABLE J.51: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
Wake Forest	07/02/78	04/16/13	123	$35,436,900	0	$0

Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Flood Damage Prevention Ordinance
All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. The Town of Wake Forest participates in the NFIP and has adopted flood damage prevention regulations.

Open Space Management Plan
The Town of Wake Forest has adopted an open space and greenways plan as well as a parks and recreation master plan.

Stormwater Management Plan
The Town of Wake Forest has not adopted a stormwater management plan; however, the town includes stormwater management regulations as part of the local unified development ordinance.

J.4.2 Administrative and Technical Capability

Table J.52 provides a summary of the capability assessment results for the Town of Wake Forest with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in the town with the specified knowledge or skill.

TABLE J.52: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	Planners with knowledge of land development/land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency Manager	Floodplain Manager	Land Surveyors	Scientists familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Resource development staff or grant writers
Wake Forest	✓	✓	✓	✓	✓		✓	✓	✓	

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

J.4.3 Fiscal Capability

Table J.53 provides a summary of the results for the Town of Wake Forest with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plan.

TABLE J.53: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes (or taxing districts)	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.
Wake Forest	✓								✓	✓

J.4.4 Political Capability

The Town of Wake Forest is currently a participant in the NFIP and has adopted the required Flood Damage Prevention Ordinance. The Unified Development Ordinance also includes erosion, stormwater, and watershed standards. This demonstrates to some extent both favorable political support and a willingness to adopt hazard mitigation efforts in an active manner.

J.4.5 Conclusions on Local Capability

Table J.54 shows the results of the capability assessment using the designed scoring methodology described in Section 7: *Capability Assessment*. The capability score is based solely on the information found in existing hazard mitigation plan and readily available on the town's government website. According to the assessment, the local capability score for the town is 40, which falls into the high capability ranking.

TABLE J.54: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
Wake Forest	40	High

J.5 TOWN OF WAKE FOREST MITIGATION STRATEGY

This subsection provides the blueprint for Wake Forest to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Regional Work Groups and the findings and conclusions of the capability assessment and risk assessment. Additional Information can be found in Section 8: *Mitigation Strategy* and Section 9: *Mitigation Action Plan*.

J.5.1 Mitigation Goals

Wake Forest developed seven mitigation goals in coordination with Wake County and the other participating municipalities. The county-wide mitigation goals are presented in **Table J.55**.

TABLE J.55: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

J.5.2 Mitigation Action Plan

The mitigation actions proposed by Wake Forest are listed in the following Mitigation Action Plan.

Town of Wake Forest Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Consider preventing all unnecessary development in the flood plains.	Flood	High	Wake Forest Planning	Local	Completed	The town prevents all unnecessary development in the floodplain through regulation. This action will be removed from the next update.
P-2	Examine and modify, if needed, policies and procedures for utility stream crossings.	All	High	Wake Forest Engineering	General Fund	Completed	Through 2014, the town has examined and modified procedures for stream crossings so this action has been completed and will be removed from the next update.
P-3	Prepare a Storm Drainage Master Plan to include all storm drainage, infrastructure, and capacity analysis.	Flood	High	Wake Forest Engineering	General Fund	2017	A Storm Drainage Master Plan has been developed to include drainage, infrastructure and capacity analysis. However, this plan will need to be reviewed and updated going forward so the action will remain in the plan.
P-4	Maintain inventory of dams.	Dam Failure	High	Wake Forest Engineering	General Fund	Completed	An inventory of dams has been built and is updated when necessary. This action will be removed from the next update.
P-5	Maintain clear right-of-ways by removing fallen trees.	Flood, Hurricane, Thunderstorm	High	Wake Forest Power	Electric Fund	Completed	Fallen trees are cleared as quickly as possible so that right of ways can be maintained. This action will be removed from the next update as a capability.
P-6	Ensure that as many electric lines as possible are looped.	Flood, Hurricane, Thunderstorm	High	Wake Forest Power	Electric Fund	Completed	Electric lines are looped whenever possible. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-7	Ensure that underground equipment is installed above the flood plain.	Flood, Hurricane, Thunderstorm	High	Wake Forest Power	Electric Fund	Completed	No development is permitted in floodplains by ordinance. This action will be removed from the next update as a capability.
P-8	Enforce burn bans and the littering ordinance regarding the discarding of cigarette butts during times of drought.	Wildfire	High	Wake Forest Police	General Fund	Completed	Burn bans and the littering ordinance are enforced, especially during drought periods. This action will be removed from the next update as a capability.
P-9	Update annually the hazardous material inventory, as required by law.	Hazardous Materials Incident	High	Wake Forest Inspections and Fire	General Fund, Fire Tax Revenue	Completed	The hazardous material inventory is reviewed and updated annually. This action will be removed from the next update as a capability.
P-10	Add amendments to the hazardous materials inventory as frequently as the information is available.	Hazardous Materials Incident	High	Wake Forest Inspections and Fire	General Fund, Fire Tax Revenue	Completed	Amendments have been added to the inventory very quickly in the past and this will continue to be done in the future. This action will be removed from the next update as a capability.
P-11	Obtain an inventory of hazardous material storage sites within a five mile radius of town.	Hazardous Materials Incident	High	Wake Forest Fire and/or Wake and Franklin Counties	General Fund, Fire Tax Revenue, County	Completed	An inventory of these sites has been obtained. This action will be removed from the next update as a capability.
P-12	Coordinate with Wake County and with the Wake County Plan on nuclear accident planning.	Nuclear	High	Wake Forest Fire and Police	General Fund	Completed	The town regularly coordinates with Wake County on nuclear planning. This action will be removed from the next update as a capability.
P-13	Identify high occupancy areas along US#1 which may be heavily impacted in the event of an accident along the highway.	Nuclear	Moderate	Wake Forest Fire and Police	General Fund	Completed	High occupancy areas along US 1 have been identified. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-14	Cooperate with Wake County Public Safety in developing a Terrorist Response Plan.	Terrorist Threat	High	Wake Forest Fire and Police Coordinator	General Fund	Completed	Wake County has developed a Terrorist Response Plan. This action will be removed from the next update as a capability.
P-15	Identify security issues with utilities.	Terrorist Threat	High	Wake Forest Public Works and Power	General Fund and Electric Fund	Completed	The town has identified high risk utilities and potential security issues. This action will be removed from the next update as a capability.
P-16	Security measures in effect at the new Town Hall, when completed.	Terrorist Threat	High	Wake Forest Town Administration	General Fund	Completed	The town has implemented security measures at the new town hall. This action will be removed from the next update as a capability.
P-17	Review and revise the existing response plan and call list, as needed	All	High	Wake Forest Administration	General Fund	2016	The town has reviewed and revised the existing response list. However, this list will need to be updated in the near future, so this action will remain in the plan.
P-18	Put electric distribution lines underground.	All	Low	Wake Forest Power	Electric Fund and General Fund	2019	Where feasible, electric lines have been put underground. However, there are still some lines that could be buried and the town will look into carrying that out going forward.
P-19	Require, where possible, multiple accessibility routes through proper design of the street layout.	All	High	Wake Forest Planning	General Fund	Completed	Transportation Plan updated to include multiple accessibility in many areas. Plan is being implemented.
P-20	Coordinate with nearby counties, including Franklin and Granville, as well as Wake.	All	High	Wake Forest Fire and Police and Communications	General Fund and Fire Tax Revenue	Completed	The town coordinates across several counties on many planning and EM activities. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-21	Develop a policy for preplanning before an event.	All	High	Wake Forest Public Works, Fire, Police, Administration, and Communications	General Fund and Fire Tax Revenue	Completed	The town has developed a policy for pre-planning prior to an event that coordinates with Wake County. This action will be removed from the next update as a capability.
P-22	Review and revise the existing call list, as needed.	All	High	Wake Forest Administration	General Fund	Deleted	This action has been determined not to be extremely applicable to mitigation so it was deleted
P-23	Adopt and implement a tree trimming and maintenance procedure for power lines.	All	High	Wake Forest Electric, Urban Forestry Board	Electric Fund	Completed	A tree trimming and maintenance policy was developed and is in place. This action will be removed from the next update as a capability.
P-24	Adopt and implement a policy of tree swapping (tall for understory trees under lines).	All	Moderate	Wake Forest Power, Urban Forestry Board	Electric Fund, General Fund	Completed	A policy for tree swapping has also been developed and is in place. This action will be removed from the next update as a capability.
P-25	Adopt a policy to power down before major damage is done and make the public aware of this policy.	All	High	Wake Forest Electric	Electric Fund	Completed	A policy to power down before major events and reduce the risk of major damage has been adopted and implemented. This action will be removed from the next update as a capability.
P-26	Develop and implement a policy to inspect utility poles and replace them, as needed.	All	High	Wake Forest Electric	Electric Fund	Completed	A policy to inspect utility poles prior to events has been adopted and is currently being implemented. This action will be removed from the next update as a capability.
P-27	Review problem areas, determine needs, and set priorities for putting lines underground or for relocating overhead lines.	All	High	Wake Forest Power	Electric Fund	Deleted	Similar to P-18, combine and delete

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-28	Require that new development install underground wiring.	All	High	Wake Forest Planning and Power	General Fund and Electric Fund	Completed	New development is required to install underground wiring. This action will be removed from the next update as a capability.
P-29	Develop policy to include putting lines underground as other town projects are constructed.	All	High	Wake Forest Administration and Power	General Fund and various project grants	Completed	When other town projects are constructed, lines are put underground. This action will be removed from the next update as a capability.
P-30	Implement the water conservation policy.	All	High	Wake Forest Administration and Power	General Fund	Completed	The town follows City of Raleigh Policy for water conservation. This action will be removed from the next update as a capability.
P-31	Prohibit new in-ground irrigation systems that are tapped into the City of Raleigh system.	All	High	Wake Forest Inspections	General Fund	Deleted	This action was determined to not be technically feasible so it was deleted.
Structural Projects							
SP-1	Conduct stream mitigation projects on Old Mill Stream, Richland Creek, and others subject to flooding or erosion.	Erosion	Moderate	Wake Forest Engineering	General Fund, Clean Water Management Trust Fund, Ecosystem Enhancement Program	2019	Some mitigation projects have been conducted on these water bodies, but there is significant effort that is still needed to reduce potential erosion. The town will work to complete more erosion control projects going forward.
Emergency Services							
ES-1	Require lockboxes at hazardous material storage sites for the Fire Dept.	Hazardous Materials Incident	High	Wake Forest Fire	Property owners	Completed	Lockboxes are required at HazMat storage sites. This action will be removed from the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-2	Forward inventory updates and amendments, along with information on risks and potential hazards, to all emergency response organizations.	Hazardous Materials Incident	High	Wake Forest Emergency Management Coordinator (Police)	General fund	Completed	Inventory updates and other information are forwarded to all emergency response organizations. This action will be removed from the next update as a capability.
ES-3	Coordinate with County school system, local school personnel, including Franklin Academy, and Wake County Public Safety Emergency Management.	All	High	Wake Forest Fire, Police, and Emergency Management Coordinator	General Fund	Completed	The town coordinates with the school system, including private schools, on emergency management issues. This action will be removed from the next update as a capability.
ES-4	Provide for primary or mobile generators to shelter sites.	All	Moderate	Wake County Emergency Management	General Fund	2018	Generators in some form are available to shelter sites. However, additional generators would be useful and will be pursued where possible.
ES-5	Coordinate with suppliers of all basic supplies for shelters.	All	High	Wake Forest Administration and Finance	General Fund	Completed	The town coordinates with suppliers to ensure that all shelters are well-equipped with the necessary supplies. This action will be removed from the next update as a capability.
ES-6	Coordinate with suppliers and develop a resource list for fuel and power generation.	All	High	Wake Forest Finance	General Fund	2016	The town coordinates with suppliers to ensure that all shelters are well-equipped with fuel and power generation. This action will be removed from the next update as a capability.
ES-7	Investigate methods of encouraging gas stations to acquire backup generators.	All	High	Wake Forest Public Works and Inspections	General Fund	2017	The town has looked into ways to encourage gas stations to acquire backup generators. In some cases this has occurred, but more work is needed to ensure adequate supply.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-8	Assess facilities for the need for emergency generation, giving consideration to alternate facility sites.	All	High	Wake Forest Public Works	General Fund	2018	The town has assessed facilities for the need for emergency generation and many facilities have been fitted with generators. However, additional facilities with emergency generation would be useful.
ES-9	Locate generators at necessary facilities, including alternate emergency sites.	All	High	Wake Forest Public Works and Public Buildings	General Fund	Deleted	Similar to ES-8, combine and delete
ES-10	See that all nursing homes and assisted living facilities have backup generators.	All	High	Property owners	Property owners	2018	Although many nursing homes and assisted living facilities have backup generators, this is still a task that remains incomplete so it will remain in the plan.
ES-11	Require, in the contract, that fuel suppliers have backup generators.	All	High	Wake Forest Administration, Finance, and Public Works	Contract holder	2018	Although many fuel suppliers have backup generators, this is still a task that remains incomplete so it will remain in the plan.
ES-12	Develop one or more clearance teams of emergency personnel, coordinating with the Wake Forest Fire Department in this process.	All	High	Wake Forest Fire and Public Works	General Fund and Fire Tax Revenue	Completed	The Fire Department has developed clearance teams to help remove downed trees and other potential debris. This action will be removed from the next update.
ES-13	Train the clearance teams and supply them with chain saws and other emergency equipment.	All	High	Wake Forest Fire and Public Works	General Fund and Fire Tax Revenue	Completed	The Fire Department has trained clearance teams to help remove downed trees and other potential debris. This action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-14	Follow a specified policy on the use of brine, sand, and plowing to reduce the impact of a storm.	Severe Winter Weather	High	Wake Forest Public Works	General Fund	Completed	A policy has been developed to guide the use of brine, sand, and plowing to reduce the impact of winter storms. This action will be removed from the next update.
ES-15	Implement the county-wide 800 trunking system.	All	High	Wake Forest Police	General Fund, Electric Fund	Completed	A county-wide trunking system has been developed and is in place. This action will be removed from the next update.
ES-16	Purchase necessary communication equipment.	All	High	Each department purchases their own	General Fund	Completed	Communication equipment has been purchased and is utilized by each department in the town. This action will be removed from the next update.
ES-17	Train personnel to use communication equipment.	All	High	Wake Forest Administration	General Fund	Completed	Personnel in each department have been trained to use the communication equipment. This action will be removed from the next update.
ES-18	Coordinate with the natural gas company regarding the gas supply and potential hazards after an event.	All	High	Wake Forest Fire and Police	General Fund	Completed	The natural gas company has been coordinated with concerning how to supply gas after a hazard event. This action will be removed from the next update.
Public Education and Awareness							
PEA-1	Develop or revise a procedure for communication with employees and the public, including alternatives if the existing system fails.	All	High	Wake Forest Communication	General Fund	Completed	The town has developed a system for communicating with employees and the public concerning severe weather and alternative means of contact have been developed as well. This action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-2	Inform the public periodically about emergency policies.	All	High	Wake Forest Communications	General Fund	Completed	Done – Town contacts residents on call / email list when emergencies happen. This action will be removed from the next update.
PEA-3	Develop a policy and advise the public that all outside above ground LP or propane gas tanks be cut off during a major event.	All	Moderate	Wake Forest Communications	General Fund	2017	A policy is in place to advise the public of turning off propane tanks during a storm, but better outreach is needed to ensure this occurs. Therefore the town will continue to work on an outreach program.

Annex K
Town of Wendell

This annex includes jurisdiction-specific information for the Town of Wendell. It consists of the following five subsections:

- K.1 Town of Wendell Community Profile
- K.2 Town of Wendell Risk Assessment
- K.3 Town of Wendell Vulnerability Assessment
- K.4 Town of Wendell Capability Assessment
- K.5 Town of Wendell Mitigation Strategy

K.1 TOWN OF WENDELL COMMUNITY PROFILE

K.1.1 Geography and the Environment

Wendell is town located in Wake County in the state of North Carolina. It was incorporated in 1903 and was settled in the 19th century when farmers from nearby Granville County decided to move to more fertile ground for farming.

Overall, Wake County is known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Summer temperatures generally venture into the 90s for highs and cool off to the 70s at night. Winter temperatures in can drop to below freezing but generally highs are in the 50s. Rainfall is most common in the summer months but occurs consistently throughout the year.

K.1.2 Population and Demographics

According to the 2010 Census, Wendell has a population of 5,845 people. The jurisdiction has seen exceptional growth between 2000 and 2010, and the population density is almost 1,200 people per square mile. Population counts from the US Census Bureau for 1990, 2000, and 2010 are presented in **Table K.1**.

TABLE K.1: POPULATION COUNTS FOR WENDELL

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
WENDELL	2,822	4,247	5,845	37.63%

Source: US Census Bureau

The racial characteristics of the jurisdiction are presented in **Table K.2**. Whites make up the majority of the population in the jurisdiction, but blacks account for over 30 percent of the population.

TABLE K.2: DEMOGRAPHICS OF WENDELL

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
WENDELL	58.1%	30.2%	0.8%	10.9%	10.5%

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

K.1.3 Housing

According to the 2010 US Census, there are 2,430 housing units in Wendell, the majority of which are single family homes or mobile homes. Housing information for the jurisdiction is presented in **Table K.3**.

TABLE K.3: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Seasonal Units, Percent (2010)	Median Home Value (2006-2010)
WENDELL	1,785	2,430	6.6%	$132,600

Source: US Census Bureau

K.1.4 Infrastructure

Transportation

There are several major roadways that residents of Wendell utilize. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs, one of which is I-540/NC-540 which is a partly completed loop that connects the jurisdiction to many of the other municipalities. In addition to the Interstate, there are many major highways that residents of the municipality utilize. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways in the include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities

Electrical power in the jurisdiction is provided by two entities and Duke Energy and Wake Electric Membership Corporation with Duke Energy providing service to a majority of the service. Water and sewer service is provided by two main entities as well: The City of Raleigh Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

Community Facilities
There are a number of buildings and community facilities located throughout Wendell. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 1 fire station, 1 police station, and 2 public schools located within the county.

Citizens also have access to several parks, including three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the county, including the American Tobacco Trail which is a rails to trails project that is open to a wide variety of non-motorized uses.

K.1.5 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land as parks. There are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the jurisdiction consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

K.1.6 Employment and Industry

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

K.2 TOWN OF WENDELL RISK ASSESSMENT

This subsection includes hazard profiles for each of the significant hazards identified in Section 4: *Hazard Identification* as they pertain to Wendell. Each hazard profile includes a description of the hazard's location and extent, notable historical occurrences, and the probability of future occurrences. Additional information can be found in Section 5: *Hazard Profiles*.

K.2.1 Drought

Location and Spatial Extent
Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, Wendell has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that the county would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Historical Occurrences

According to the North Carolina Drought Monitor, Wendell has had drought occurrences all of the last fourteen years (2000-2013). **Table K.4** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE K.4: HISTORICAL DROUGHT OCCURRENCES IN WENDELL

Abnormally Dry | **Moderate Drought** | **Severe Drought** | **Extreme Drought** | **Exceptional Drought**

	Wendell
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that Wendell has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

K.2.2 Extreme Heat

Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to any geographic or political boundaries. All of Wendell is susceptible to extreme heat conditions.

Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Wendell. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the region. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the county. The most centralized location is in Raleigh at North Carolina State University. **Table K.5** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table K.5: Average Maximum Temperature in Raleigh, Wake County

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

K.2.3 Hailstorm

Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Wendell is uniformly exposed to severe thunderstorms; therefore, all areas are equally exposed to hail which may be produced by such storms.

Historical Occurrences

According to the National Climatic Data Center, 6 recorded hailstorm events have affected Wendell since 1993.[1] **Table K.6** is a summary of the hail events in Wendell. **Table K.7** provides detailed information about each event that occurred. In all, hail occurrences resulted in $0 (2013 dollars) in property damages. Hail ranged in diameter from 0.75 inches to 1 inch. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value.

Table K.6: Summary of Hail Occurrences in Wendell

Location	Number of Occurrences	Property Damage (2013)
Wendell	6	$0

Source: National Climatic Data Center

[1] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Wendell. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

TABLE K.7: HISTORICAL HAIL OCCURRENCES IN WENDELL

	Date	Magnitude	Deaths/Injuries	Property Damage*
Wendell				
Wendell	5/19/1993	1.75 in.	0/0	$0
Wendell	6/8/1995	0.75 in.	0/0	$0
WENDELL	6/4/1996	1 in.	0/0	$0
WENDELL	5/14/2006	0.75 in.	0/0	$0
WENDELL	5/26/2006	0.75 in.	0/0	$0
WENDELL	6/6/2006	0.75 in.	0/0	$0
WENDELL	5/9/2008	0.75 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that Wendell has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the county.

K.2.4 Hurricane and Tropical Storm

Location and Spatial Extent

Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Wendell. The entire jurisdiction is equally susceptible to hurricane and tropical storms.

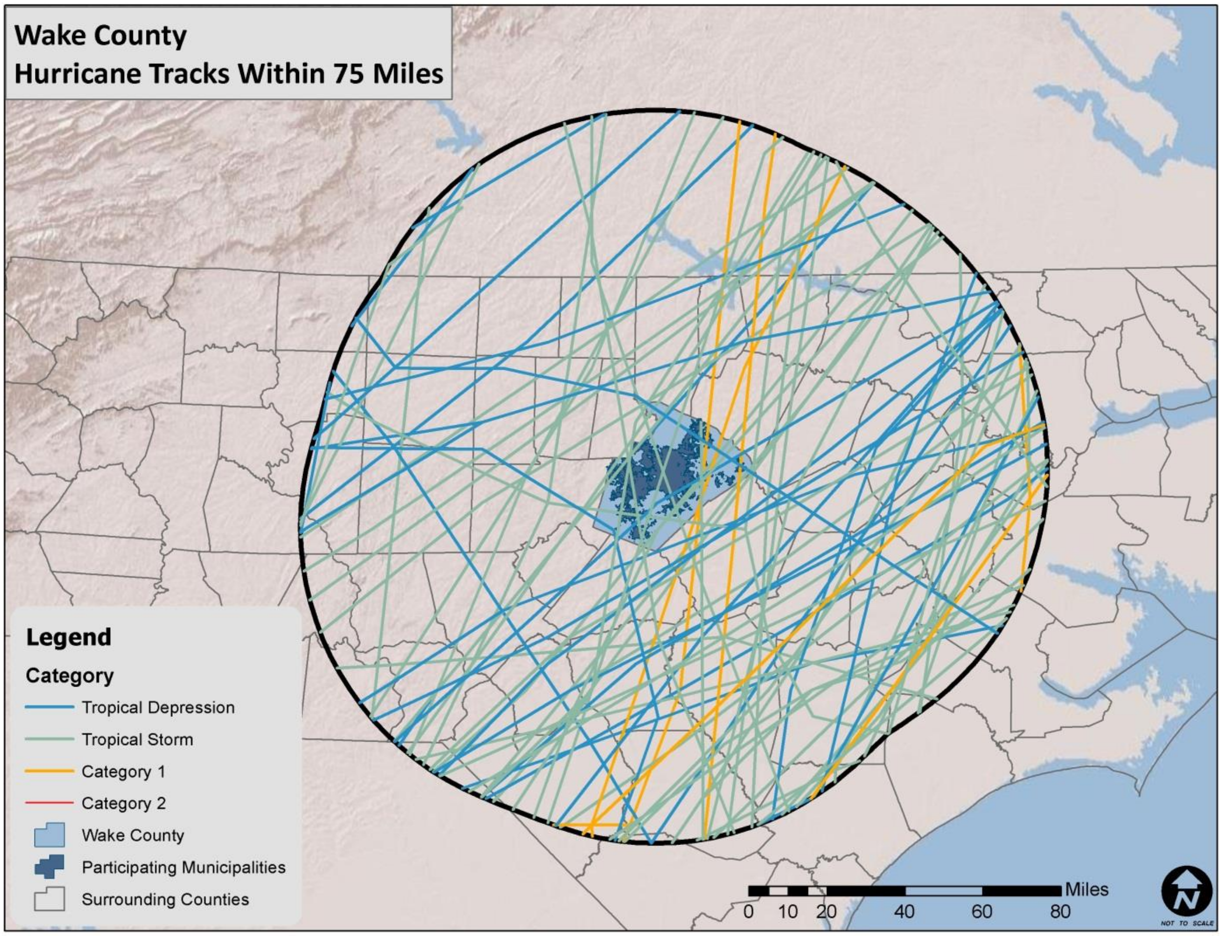
Historical Occurrences

According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[2] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms have traversed directly through Wake County as shown in **Figure K.1**. **Table K.8** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

[2] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

FIGURE K.1: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE K.8: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1
1882	NOT NAMED	53	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm
1959	CINDY	26	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression
2008	HANNA	40	Tropical Storm

Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Wendell between 1950 and 2013. These storms are listed in **Table K.9** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE K.9: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made in 1996 (Hurricane Fran), 1999 (Hurricane Floyd), and 2003 (Hurricane Isabel) for the county.[3]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Tropical Storm Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

Probability of Future Occurrences
Given the inland location of the jurisdiction, it is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Wendell. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the jurisdiction is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

[3] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

K.2.5 Lightning

Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Wendell is uniformly exposed to lightning.

Historical Occurrences

According to the National Climatic Data Center, there has been one recorded lightning event in Wendell since 1950, as listed in summary **Table K.10** and detailed in **Table K.11**.[4] However, it is certain that more lightning events have in fact impacted the jurisdiction. Many of the reported events are those that caused damage, and it should be expected that damages are likely much higher for this hazard than what is reported.

TABLE K.10: SUMMARY OF LIGHTNING OCCURRENCES IN WENDELL

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Wendell	1	0/0	$622,905

Source: National Climatic Data Center

TABLE K.11: HISTORICAL LIGHTNING OCCURRENCES IN WENDELL

	Date	Deaths/Injuries	Property Damage*	Details
Wendell				
WENDELL	8/22/2003	0/0	$622,905	Lightning set fire to a home, destroying it.

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Although there were not a high number of historical lightning events reported in Wendell via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S. National Lightning Detection Network (NLDN®), Wendell is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the jurisdiction.

K.2.6 Severe Thunderstorm/High Wind

Location and Spatial Extent

A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Wendell. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Also, Wendell typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Wendell has uniform exposure to an event and the spatial extent of an impact could be large.

Historical Occurrences

Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011.[5] According to NCDC, there have been 1 reported thunderstorm/high wind event since 1994 for high wind and since 1950 for thunderstorms.[6] This event caused over $24,000 (2013 dollars) in damages. **Table K.12** summarizes this information. **Table K.13** presents detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event.[7]

TABLE K. 12: SUMMARY OF THUNDERSTORM/HIGH WIND OCCURRENCES IN WENDELL

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Wendell	1	0/0	$24,303

Source: National Climatic Data Center

TABLE K.13: HISTORICAL THUNDERSTORM/HIGH WIND OCCURRENCES IN WENDELL

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Wendell					
WENDELL	5/1/1997	TSTM WIND	50 kts.	0/0	$24,303

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire jurisdiction.

K.2.7 Tornado

Location and Spatial Extent

Tornadoes occur throughout the state of North Carolina, and thus in Wendell. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Wendell is uniformly exposed to this hazard.

[5] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional thunderstorm events have occurred in Wendell. As additional local data becomes available, this hazard profile will be amended.
[7] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

Historical Occurrences

Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there have been two recorded tornado events in Wendell since 1956 (**Table K.14**), resulting in nearly $0 (2013 dollars) in property damages.[8] Detailed information on this event can be found in **Table K.15**. The magnitude of this tornado was a F1 in intensity, although an F5 event is possible. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is likely that a high number of occurrences have gone unreported over the past 50 years.

TABLE K.14: SUMMARY OF TORNADO OCCURRENCES IN WENDELL

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Wendell	2	0/26	$4,988,724

Source: National Climatic Data Center

TABLE K.15: HISTORICAL TORNADO IMPACTS IN WENDELL

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Wendell					
Wendell	4/15/1996	F1	0/26	$4,972,150	The second is a series of three tornadoes began about 100 yards to the SE of where the first tornado began (off Hwy 64 in Wendell). The storm was initially less than 25 yards wide asit moved NNE and twisted trees and blew shingles off several houses. About one half mile from the initial touchdown, the storm widened to 50 yards as it approached the town of Zebulon. Trees were downed and the roof was blown off a brick home near the railroad tracks. Another home and a manufactured home were damaged as the storm crossed a street and moved up a hill. The storm then preceded over and down the hill into a mobile home park. Damage was extensive to all the trailers in the park that were directly in the path. The storm continued moving NNE into downtown Zebulon where it downed numerous large trees. Houses in the direct path of the storm were all brick and sustained only roof damage. The Zebulon Middle School sustained major roof damage to the main building. The tornado was last noted at Karial and Old Bunn Roads where minor damage occurred to a frame house and

[8] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Wendell. As additional local data becomes available, this hazard profile will be amended.

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
					severel trees were twisted
Wendell	4/15/1996	F0	0/0	$16,574	An F0 tornado initially touched down off Hwy 64 in Wendell. The tornado width was initially only 50 feet where several trees were taken down. The tornado increased in width to 200 yards as it paralleled Hwy 64 and moved into the west side of the town of Zebulon. The storm damaged the Courtesy Car Dealership and tossed a showroom car across the highway. Numerous trees were twisted and felled. The tornado then crossed the highway and narrowed significantly as it reached Hwy 96 and Greenspeace Road about 0.3 miles west of the Wakefield community where it lifted.

*Property Damage is reported in 2013 dollars.
Source: NCDC

2011 Tornadoes- April 16, 2011
In 2011, the county and all of its jurisdictions were impacted by one of the worst tornado-related events in the county's recorded history. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries.

Probability of Future Occurrences
According to historical information, tornado events are not an annual occurrence for the jurisdiction. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Wendell experience a direct tornado strike. The probability of future tornado occurrences affecting Wendell is likely (10-100 percent annual probability).

K.2.8 Winter Storm and Freeze

Location and Spatial Extent
Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Wendell is accustomed to smaller scale severe winter weather conditions and often receives severe winter weather during the winter months. Given the atmospheric nature of the hazard, the entire jurisdiction has uniform exposure to a winter storm.

Historical Occurrences

Severe winter weather has resulted in six disaster declarations in Wendell. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. [9] According to the National Climatic Data Center, there have been no recorded winter storm events in Wendell since 1993 (**Table K.16**).[10] These events resulted in $0 (2013 dollars) in damages. However, there have been 28 recorded countywide events and most severe winter weather events are only recorded at the county level.

TABLE K.16: SUMMARY OF WINTER STORM EVENTS IN WENDELL

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Wendell	0	0/0	$0

Source: National Climatic Data Center

There have been several severe winter weather events in Wendell. The text below describes one of the major events and associated impacts on the county. Similar impacted can be expected with severe winter weather.

1996 Winter Storm

This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and power outages. Furthermore, citizens may resort to using inappropriate heating devices that could to fire or an accumulation of toxic fumes.

Probability of Future Occurrences

Winter storm events will remain a somewhat regular occurrence in Wendell due to location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

K.2.9 Earthquake

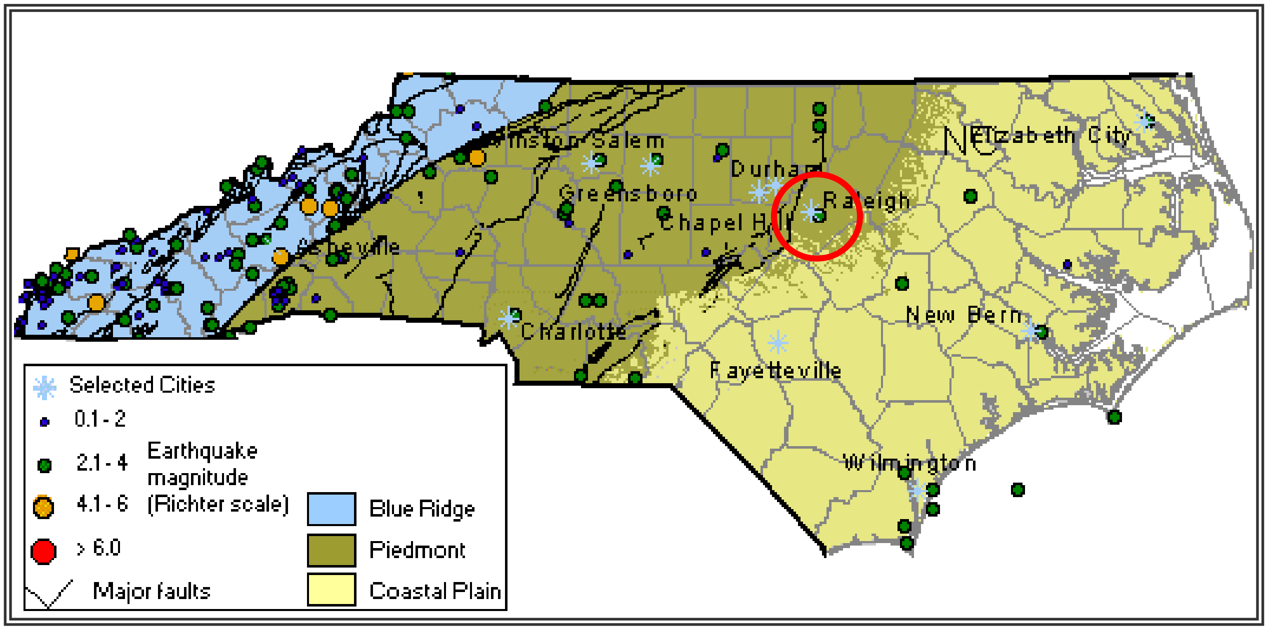
Location and Spatial Extent

Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina. **Figure K.2** is a map showing geological and seismic information for North Carolina.

[9] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.

[10] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional winter storm conditions have affected Wendell.

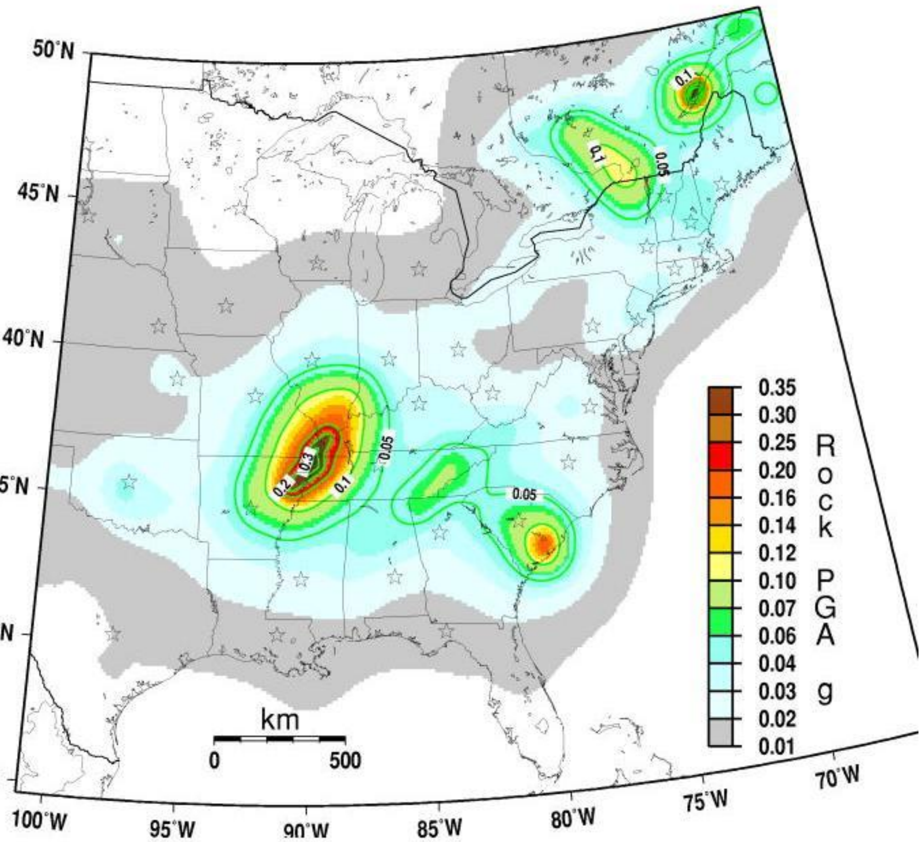
FIGURE K.2: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure K.3 shows the intensity level associated with Wendell, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Wendell lies within an approximate zone of level "2" to "3" ground acceleration. This indicates that the county exists within an area of moderate seismic risk.

FIGURE K.3: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

Historical Occurrences

Although no earthquakes are known to have occurred directly in Wendell since 1874, several have occurred in the county and affected the municipality. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table K.17** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table K.18** presents a detailed occurrence of each event including the date, distance for the epicenter, and Modified Mercalli Intensity (if known).[11]

TABLE K.17: SUMMARY OF SEISMIC ACTIVITY IN WENDELL

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Wendell	--	--	--

Source: National Geophysical Data Center

[11] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

TABLE K.18: SIGNIFICANT SEISMIC EVENTS IN WENDELL (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI (magnitude)
Wendell				
None reported				

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Wendell, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table K.19.**

TABLE K.19: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 - 1	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928*	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957*	Buncombe County, NC	3.7	VI	VI
11/24/1957*	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973*	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Wendell occurrences.

** Conflicting reports on this event, intensity in North Carolina could have been either V or VI

Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Wendell is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. The annual probability level for the county is estimated between 1 and 10 percent (possible).

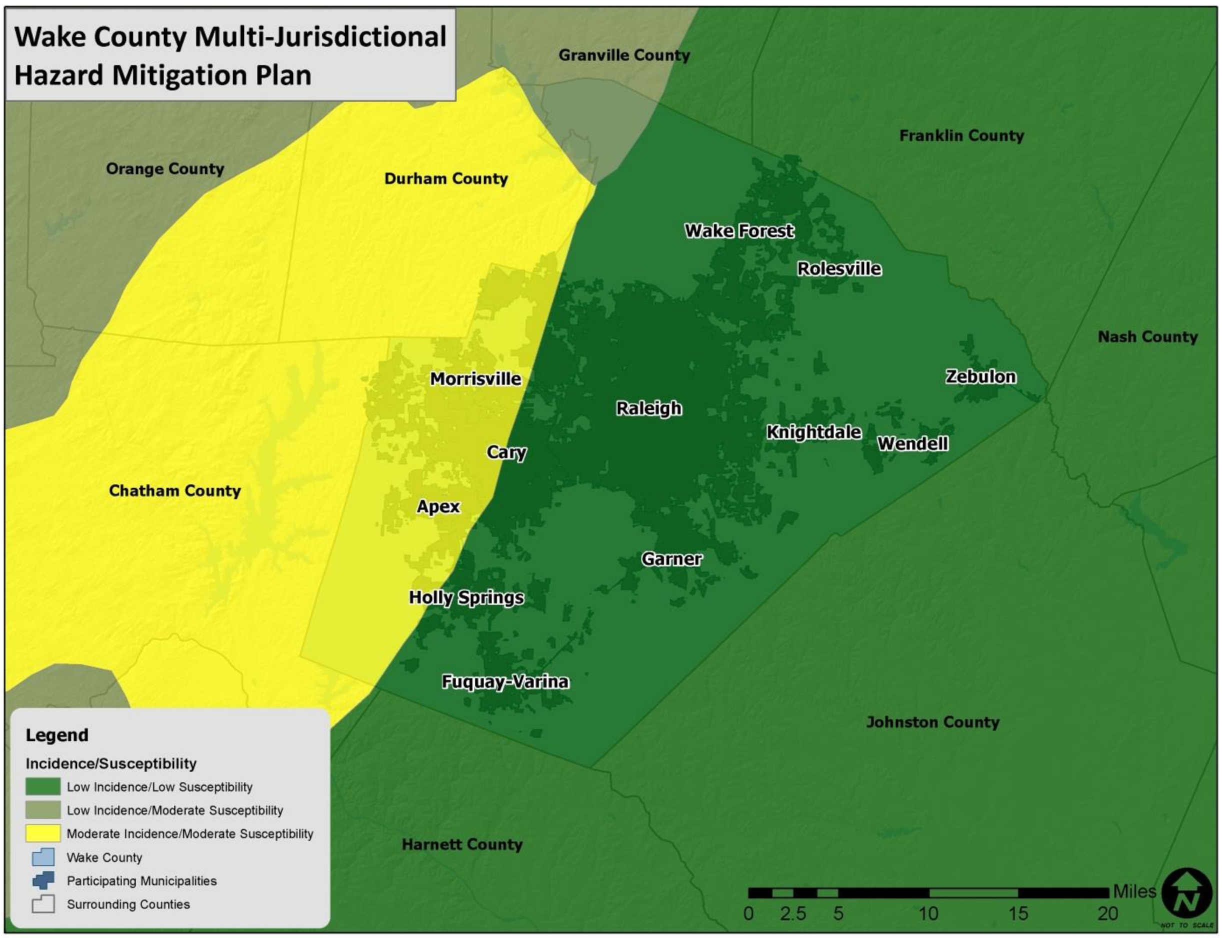
K.2.10 Landslide

Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Wendell, although the overall risk is relatively low.

According to **Figure K.4** below, the majority of the county has low landslide activity. However there is a small area along the western border of the county that has a moderate incidence and moderate susceptibility. In all other areas (including all of Wendell), there is low susceptibility.

FIGURE K.4: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

Historical Occurrences

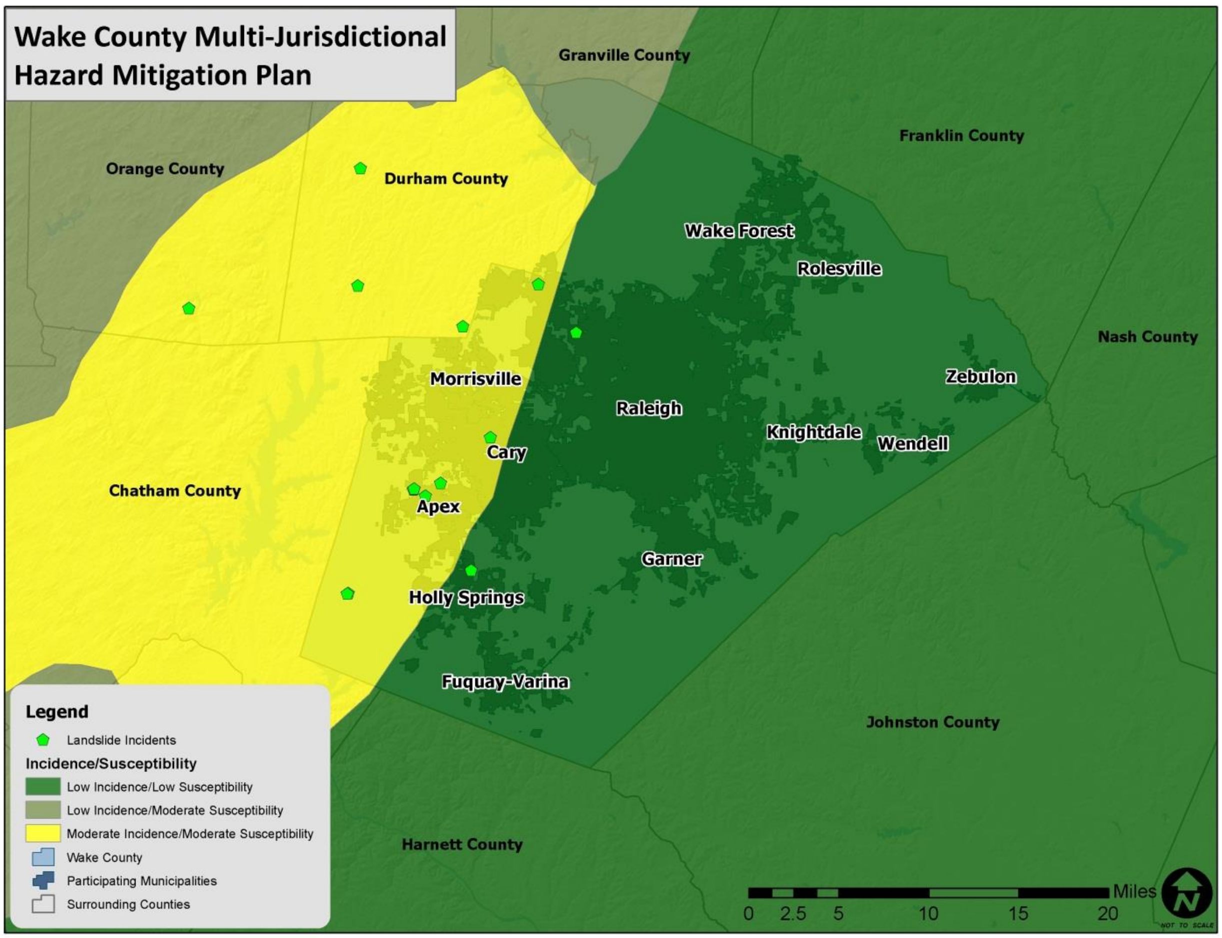
Steeper topography in some areas of Wendell make the planning area susceptible to landslides. Most landslides are caused by heavy rainfall in the area. Building on steep slopes that was not previously possible also contributes to risk. **Table K.20** presents a summary of the landslide occurrence events as provided by the North Carolina Geological Survey[12]. The georeferenced locations of the landslide events presented in the aforementioned tables are presented in **Figure K.5**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred in Wendell.

TABLE K.20: SUMMARY OF LANDSLIDE ACTIVITY IN WENDELL

Location	Number of Occurrences
Wendell	0

Source: North Carolina Geological Survey

FIGURE K.5: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for

[12] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Wendell have greater risk than others given factors such as steepness on slope and modification of slopes.

K.2.11 Dam and Levee Failure

Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table K.21** explains these classifications.

TABLE K.21: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

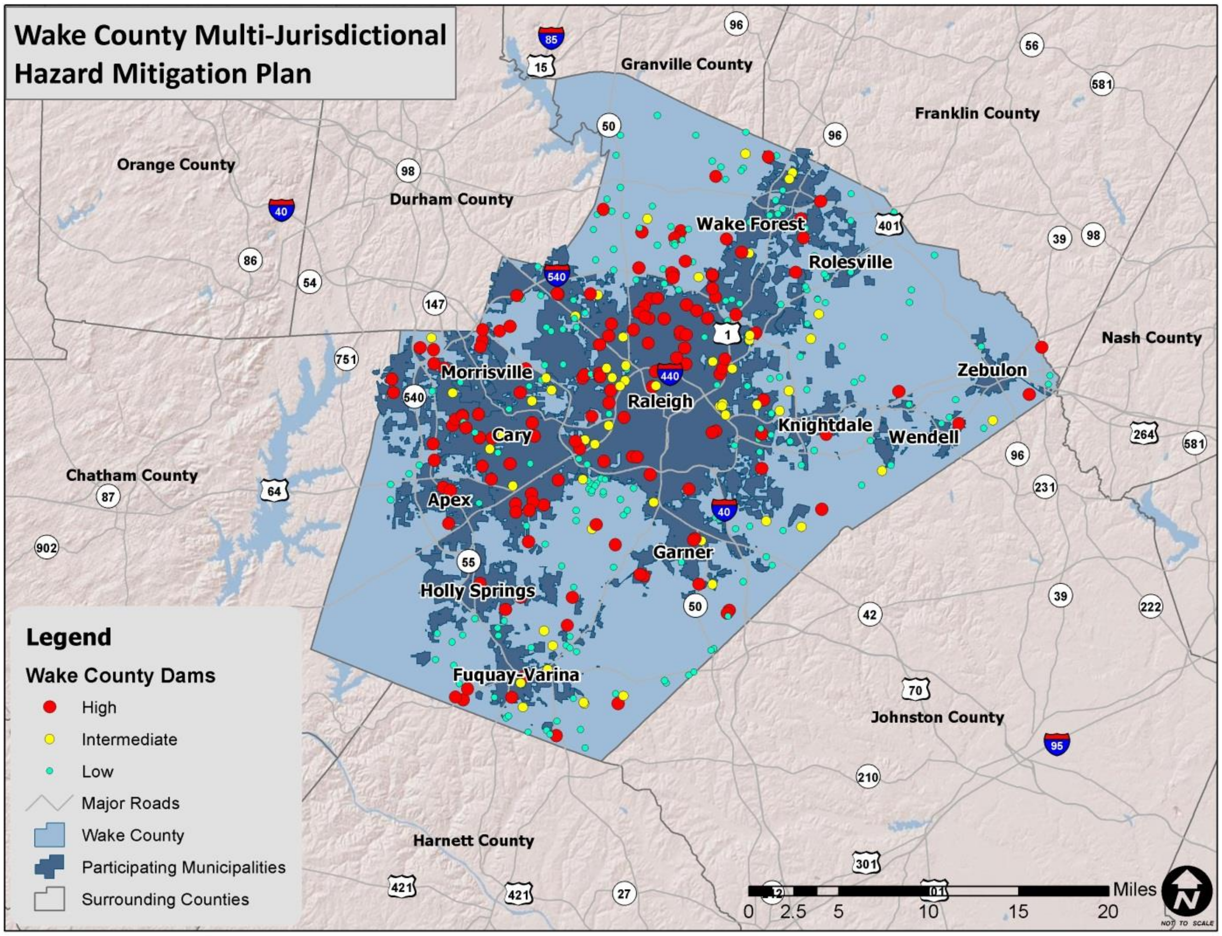
Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

According to the North Carolina Division of Land Management there are 4 dams in Wendell.[13] **Figure K.6** shows the dam location and the corresponding hazard ranking for each. Of these dams, one is classified as high hazard potential. This high hazard dam is listed in **Table K.22**.

[13] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE K.6: WAKE COUNTY DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE K.22: WENDELL HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Wendell				
Timberlake Dam	High	0	9999	

Source: North Carolina Division of Land Resources, 2012

It should also be noted that the North Carolina dam classification regulations were recently updated. As a result of the change, more dams are generally classified as high hazard.

Historical Occurrences

No dam breaches were reported in Wendell. However, several breach scenarios in the jurisdiction could cause substantial damage.

Probability of Future Occurrences

Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

K.2.12 Erosion

Location and Spatial Extent

Erosion in Wendell is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Wendell soils have greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Wendell, particularly along the banks of rivers and streams, but it is not an extreme threat. No areas of concern were reported by the planning committee.

Historical Occurrences

Several sources were vetted to identify areas of erosion in Wendell. This includes searching local newspapers, interviewing local officials, and reviewing the previous hazard mitigation plan. Little information could be found and erosion was not addressed in the previous Wendell hazard mitigation plan.

Probability of Future Occurrences

Erosion remains a natural, dynamic, and continuous process for Wendell, and it will continue to occur. The annual probability level assigned for erosion is possible (between 1 and 10 percent annually).

K.2.13 Flood

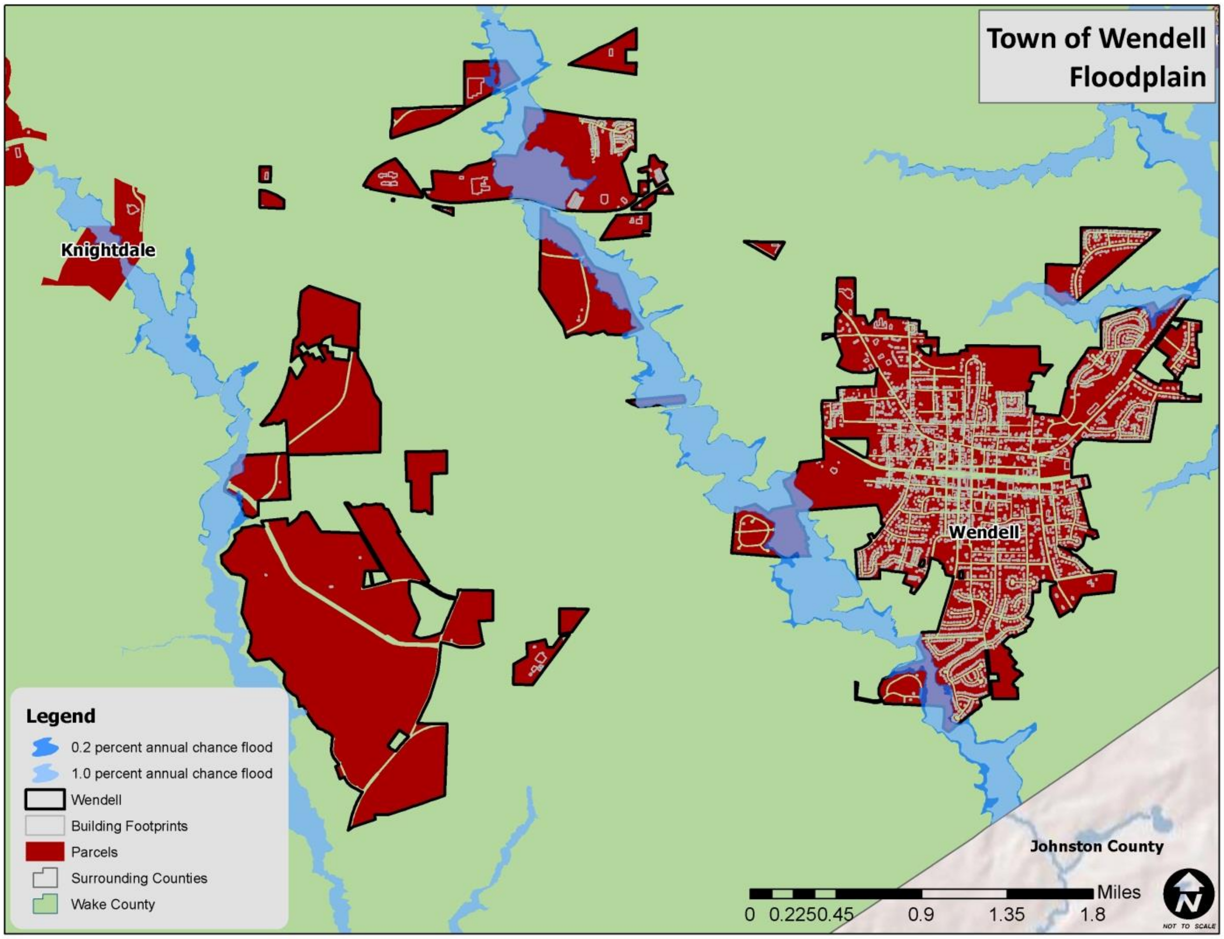
Location and Spatial Extent

There are areas in Wendell that are susceptible to flood events. Special flood hazard areas in the jurisdiction were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[14] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 5 square miles that make up Wendell, there are 0.28 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain).

These flood zone values account for 5.6 percent of the total land area in Wendell. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas. **Figure K.7** illustrates the location and extent of currently mapped special flood hazard areas for Wendell based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.

[14] The county-level DFIRM data used for Wendell were updated in 2010.

FIGURE K.7: SPECIAL FLOOD HAZARD AREAS IN WENDELL



Source: Federal Emergency Management Agency

Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported no events in Wendell since 1993.[15] A summary of these events is presented in **Table K.23**. These events accounted for $0 (2013 dollars) in property damage in the county.[16] Specific information on flood events, including date, type of flooding, and deaths and injuries, can be found in **Table K.24**.

TABLE K.23: SUMMARY OF FLOOD OCCURRENCES IN WENDELL

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Wendell	0	0/0	$0

Source: National Climatic Data Center

[15] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.
[16] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

TABLE K.24: HISTORICAL FLOOD EVENTS IN WENDELL

	Date	Type	Deaths/ Injuries	Property Damage*
Wendell				
None reported				
Source: National Climatic Data Center				

Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there have been 6 flood losses reported in Wendell through the National Flood Insurance Program (NFIP) since 1978. A summary of these figures for the jurisdiction is provided in **Table K.25**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that additional instances of flood loss in Wendell were either uninsured, denied claims payment, or not reported.

TABLE K.25: SUMMARY OF INSURED FLOOD LOSSES IN WENDELL

Location	Flood Losses	Claims Payments
Wendell	6	$77,232

Source: FEMA, NFIP

Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

As of July 2013, there are 0 non-mitigated repetitive loss properties located in Wendell, which accounted for 0 losses and $0 in claims payments under the NFIP. Without mitigation, repetitive loss properties will likely continue to experience flood losses. **Table K.26** presents detailed information on repetitive loss properties and NFIP claims and policies for Wendell.

TABLE K.26: SUMMARY OF REPETITIVE LOSS PROPERTIES IN WENDELL

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Wendell	0	-	0	$0	$0	$0	$0

Source: National Flood Insurance Program

Probability of Future Occurrences

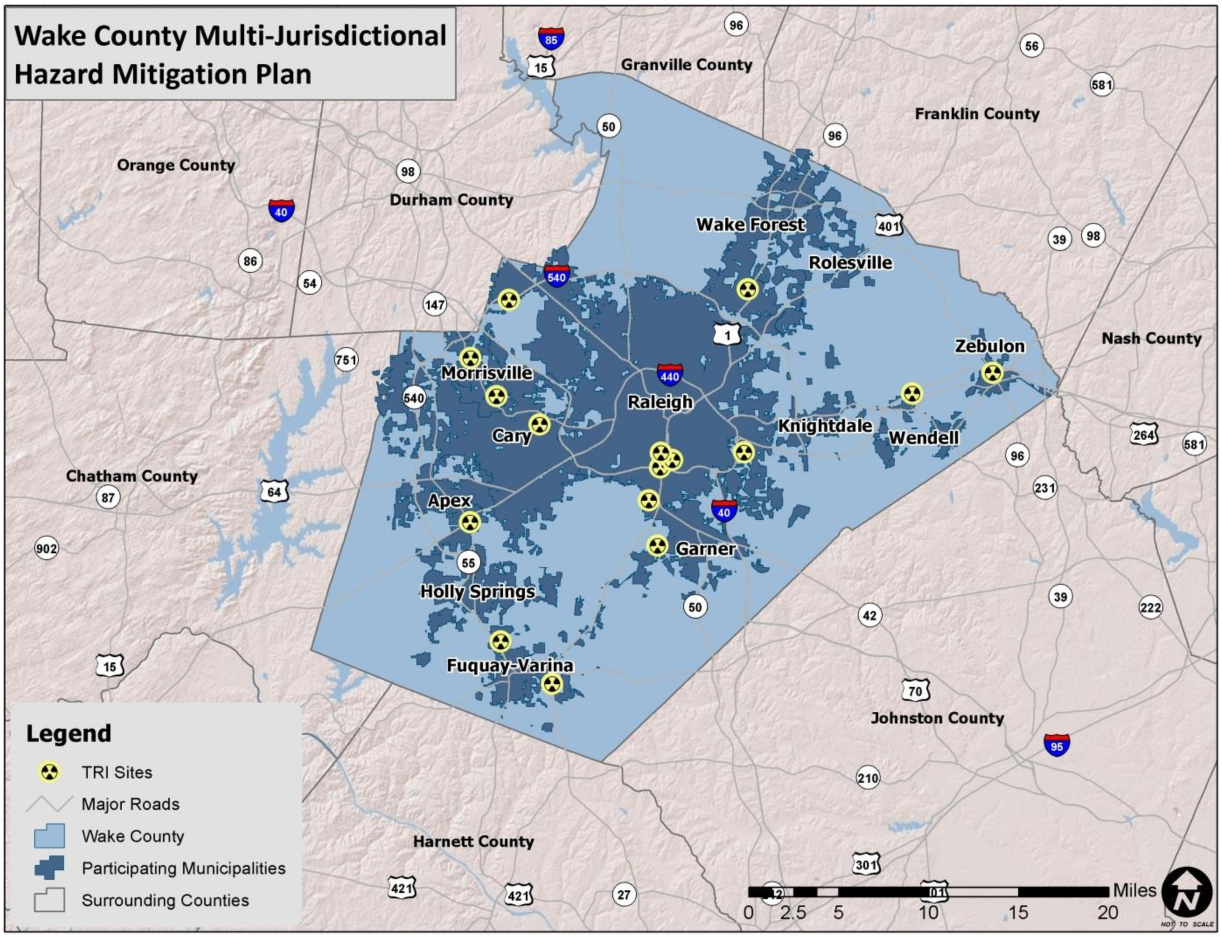
Flood events will remain a threat in areas prone to flooding in Wendell, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability) The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above**,** which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

K.2.14 Hazardous Materials Incidents

Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Wendell has no TRI sites as shown in **Figure K.8.**

FIGURE K.8: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the jurisdiction via roadways and rail. All roads that permit hazardous material transport are considered potentially at risk to an incident.

Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table K.27 presents detailed information on historic HAZMAT incidents reported in Wendell.

TABLE K.27: SUMMARY OF HAZMAT INCIDENTS IN WENDELL

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Wendell							
I-1982080279	8/3/1982	WENDELL	Highway	No	0/0	$0	1 LGA

Source: USDOT PHMSA

Probability of Future Occurrences

Although there are no toxic release inventory sites in Wendell, there are several roadways and rails that transport hazardous materials, so it is possible that a hazardous material incident may occur in the jurisdiction (between 1 percent and 10 percent annual probability). Local officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

K.2.15 Wildfire

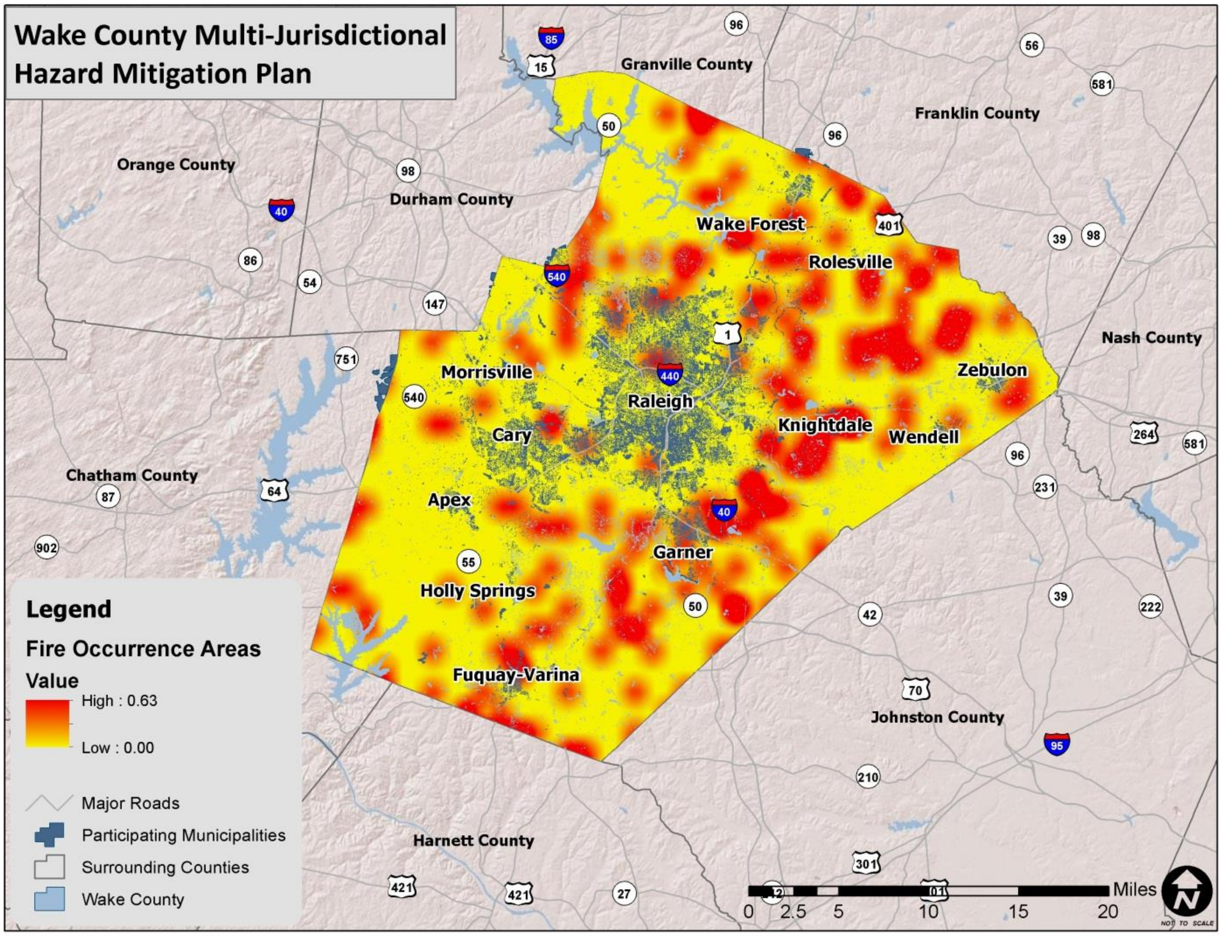
Location and Spatial Extent

The entire jurisdiction is at some risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas.

Historical Occurrences

Figure K.9 shows the Fire Occurrence Areas (FOA) in Wendell based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. Therefore, even areas classified as at relatively high risk within the county are a relatively low risk compared to other areas of the state.

FIGURE K.9: HISTORIC WILDFIRE EVENTS IN WENDELL



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of 16 wildfires annually which burn an average of 98 acres per year. The data indicates that most of these fires are small, averaging six acres per fire. **Table K.28** lists the number of reported wildfire occurrences in the county between the years 2003 and 2012.

TABLE K.28: HISTORICAL WILDFIRE OCCURRENCES IN WENDELL

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Wendell. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Wendell for future wildfire events is possible (a 1 and 10 percent annual probability).

K.2.16 Nuclear Accident

Location and Spatial Extent

The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station.

Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 "Alerts" and 28 "Notice of Unusual Events" since 1986, which are shown in **Table K.29**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table K.29: SHEARON HARRIS EMERGENCY DECLARATION HISTORY

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on "B" Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).

Emergency Declaration	Date	Description
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of “A” Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - “B” diesel generator was being worked on; in accordance with test procedures, “A” diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported “Notice of Unusual Events” since 1986, which is shown in **Table K.30**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table K.30: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Probability of Future Occurrences

A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

K.2.17 Terror Threat

Location and Spatial Extent

A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table K.31** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

TABLE K.31 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food	▪ Government Facilities
▪ Banking and Finance	▪ Healthcare and Public Health
▪ Chemical	▪ Information Technology
▪ Commercial Facilities	▪ National Monuments and Icons
▪ Communications	▪ Nuclear Reactors, Materials, and Waste
▪ Critical Manufacturing	▪ Postal and Shipping
▪ Dams	▪ Transportation Systems
▪ Defense Industrial Base	▪ Water
▪ Emergency Services	
▪ Energy	

Historical Occurrences

Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

Probability of Future Occurrences

Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

K.2.18 Conclusions on Hazard Risk

The hazard profiles presented above were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and

experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

Hazard Extent

Table K.32 describes the extent of each natural hazard identified for Wendell. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE K.32 EXTENT OF WENDELL HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page K:4). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Wendell has received this ranking three times over the fourteen year reporting period.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Wendell was 1 inch. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), Wendell is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Thunderstorm Wind/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Wendell was reported at 50 knots (approximately 58 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). The greatest magnitude reported was an F1 (reported on April 15, 1996).
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Wendell. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is low in Wendell.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). Of the 4 dams in Wendell, 1 is classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records located in Wendell.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 31.2 percent of the total land area in Wendell. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second.
Other Hazards	
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incident reported in the region is 1 LGA released on the highway in Wendell. It should be noted that larger events are possible.
Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).
Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

Priority Risk Index Results

In order to draw some meaningful planning conclusions on hazard risk for Wendell, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). More information on the PRI and how it was calculated can be found in Section 5.20.2.

Table K.33 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups and Coordinating Committee. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE K.33: SUMMARY OF PRI RESULTS FOR WENDELL

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	**2.5**
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	**2.4**
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	**2.5**
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	**2.1**
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	**3.1**
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.7**
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	**2.5**
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2**
Landslide	Unlikely	Minor	Small	Less than 6 hours	Less than 6 hours	**1.5**
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	**1.8**
Flood	Likely	Critical	Small	6 to 12 hours	Less than 1 week	**2.8**
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	**2**
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	**2.6**
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	**2.4**

K.2.16 Final Determinations on Hazard Risk

The conclusions drawn from the hazard profiling process for Wendell, including the PRI results and input from the Regional Work Groups and Coordinating, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table K.34**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Wendell. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment* and below in Section K.3. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE K.34: CONCLUSIONS ON HAZARD RISK FOR WENDELL

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood Nuclear Accident
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

K.3 TOWN OF WENDELL VULNERABILITY ASSESSMENT

This subsection identifies and quantifies the vulnerability of Wendell to the significant hazards previously identified. This includes identifying and characterizing an inventory of assets in the county and assessing the potential impact and expected amount of damages caused to these assets by each identified hazard event. More information on the methodology and data sources used to conduct this assessment can be found in Section 6: *Vulnerability Assessment*.

K.3.1 Asset Inventory

Table K.35 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for Wendell (study area of vulnerability assessment).[17]

TABLE K.35: IMPROVED PROPERTY IN WENDELL

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Wendell	2,576	$398,406,521	2,577	$287,227,420

Table K.36 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in Wendell. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. In addition, a list of secondary facilities was created to recognize the importance of these facilities in the event of a disaster. These facilities were not mapped, but it is important to recognize that they could be potentially impacted by nearly any of the identified hazards, especially those that are atmospheric or have no specific spatial delineation.

All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure K.10** shows the locations of the primary critical facilities in Wake County. **Table K.48**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility. As noted previously, this list is not all-inclusive and only includes information provided by the local government.

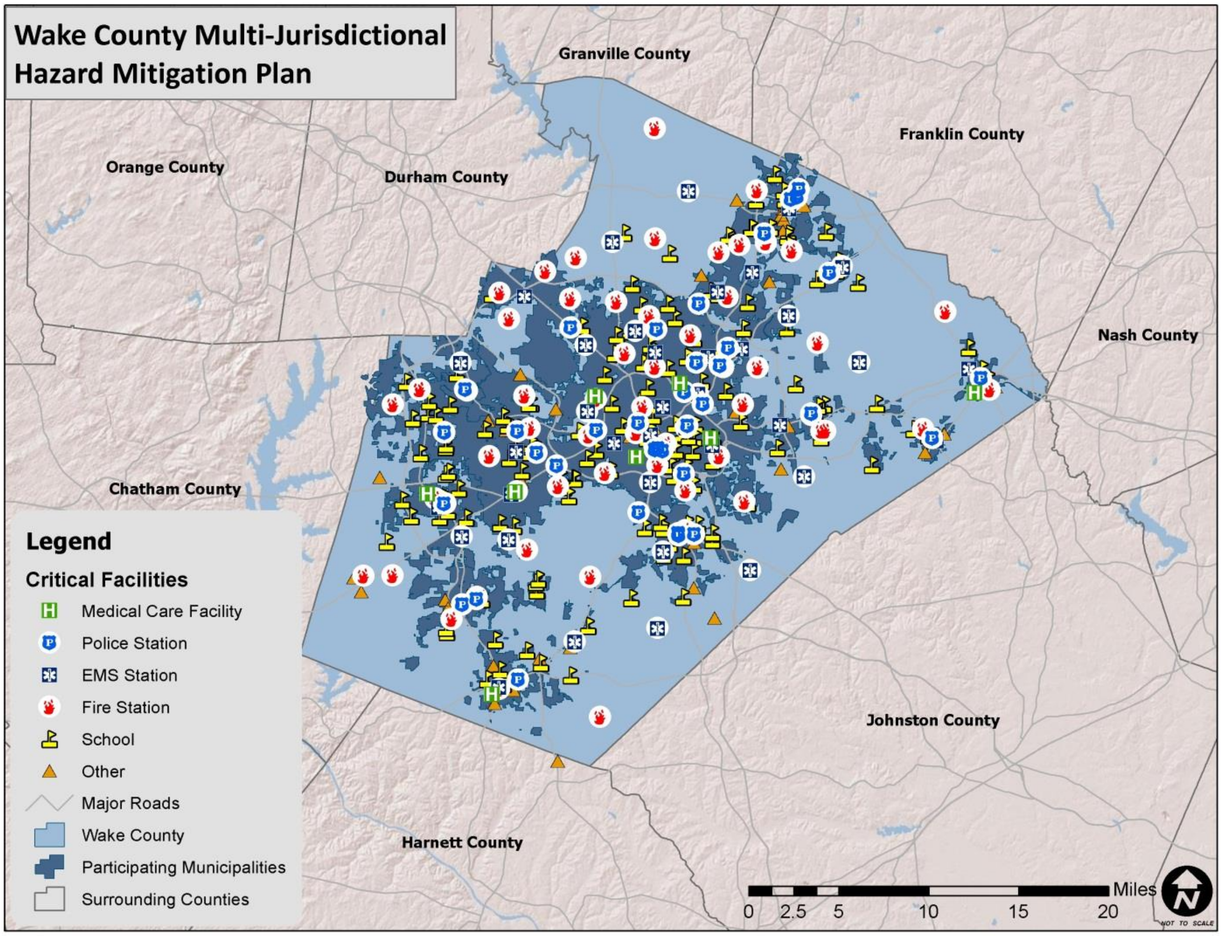
TABLE K.36: CRITICAL FACILITY INVENTORY IN WENDELL

Location	Fire Stations	Police Stations	EMS Stations	Medical Care Facilities	Schools	Other
Wendell	1	1	1	0	2	6

Source: Local Governments

[17] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

FIGURE K.10: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: Local Governments

K.3.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Wendell that are potentially at risk to these hazards.

Table K.37 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, limited the results to county-wide estimates. The total population in Wendell according to Census data is 5,845 persons. Additional population estimates are presented above in Section K.1.

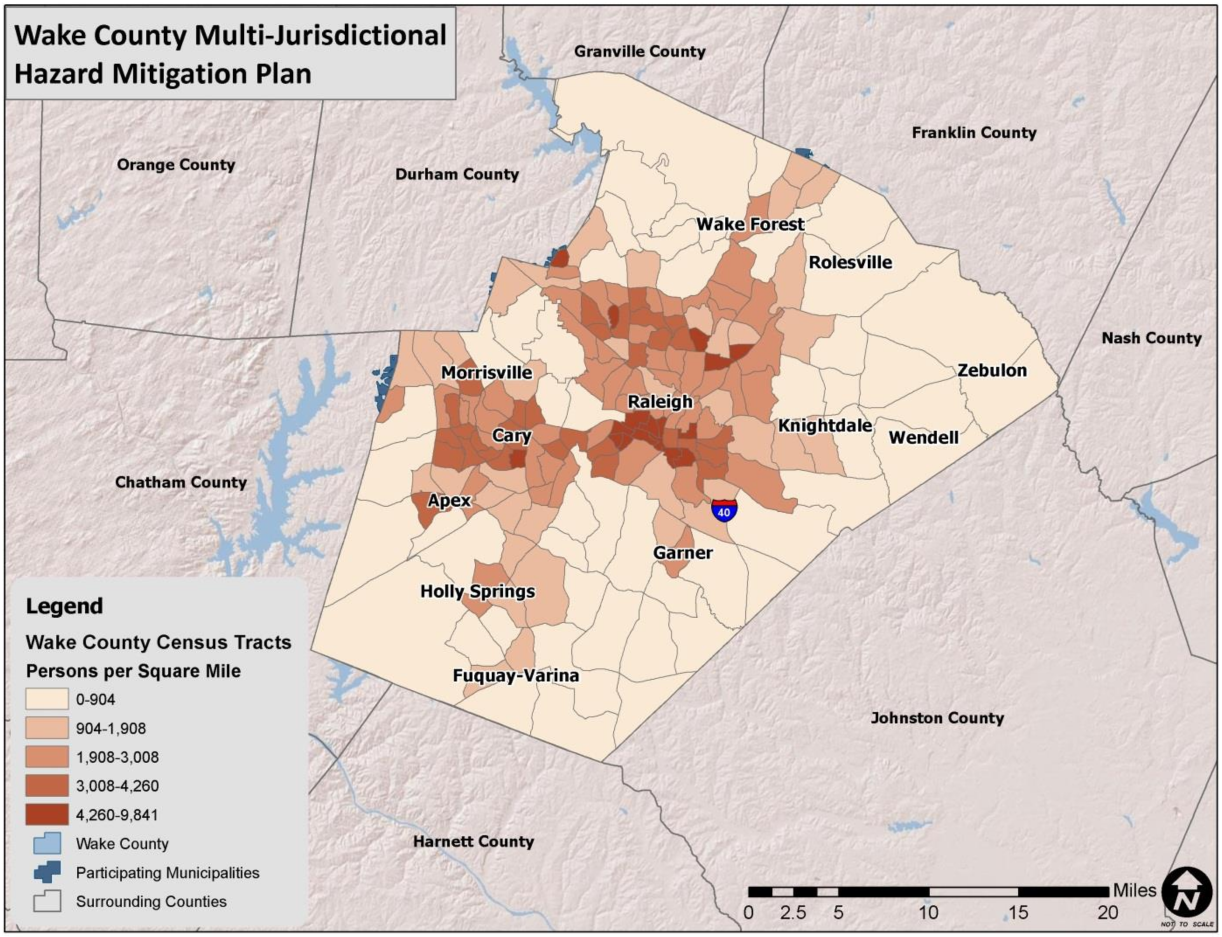
TABLE K.37: TOTAL POPULATION IN WENDELL

Location	Total 2010 Population
Wendell	5,845

Source: U.S. Census 2010

In addition, **Figure K.11** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[18]

FIGURE K.11: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

K.3.3 Vulnerability Assessment Results

As noted in Section 6: *Vulnerability Assessment*, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results, specific to Wendell, are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total county exposure, and thus risk, was presented in **Table K.35**.

The annualized loss estimate for all hazards is presented at the end of this section in **Table K.47.**

The hazards presented in this section include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

[18] Population by census block was not available at the time this plan was completed.

Hurricane and Tropical Storm

Historical evidence indicates that Wendell has a significant risk to the hurricane and tropical storm hazard. Several tracks have come near or traversed through the county, as shown and discussed in Section K.2.4.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes, and high winds and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table K.38.** Only losses to buildings are reported, in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE K.38: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table K.39.**

TABLE K.39: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Wendell	76.6	85.6	103.0	110.3

Source: Hazus-MH 2.1

Social Vulnerability

Given equal susceptibility across the county, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Wendell, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table K.48** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Wendell. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

Earthquake

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table K.40** summarizes the findings.

TABLE K.40: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability

It can be assumed that all existing future populations are at risk to the earthquake hazard.

Critical Facilities

The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table K.48**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Wendell. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

Landslide

In order to complete the vulnerability assessment for landslides in Wendell, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section K.2.10), tax parcel and building footprint data, and GIS analysis. **Table K.41** presents the potential at-risk property where available. All areas of Wendell are identified as low incidence areas by the USGS landslide data. Since there were no high incidence levels in the county, the moderate incidence level was used to identify different areas of concern for the analysis below.

TABLE K. 41: TOTAL POTENTIAL AT-RISK PARCELS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	Moderate		
Wendell	0	0	$0

Source: USGS

Social Vulnerability
Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides.

Critical Facilities
No critical facilities are located in a moderate susceptibility area. A list of specific critical facilities and their associated risk can be found in **Table K.48** at the end of this section.

In conclusion, a landslide has the potential to impact existing and future buildings, facilities, and populations in Wendell, though some areas are at a higher risk than others due to a variety of factors. For example, steep slopes and modified slopes bear a greater risk than flat areas. Specific vulnerabilities for county assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

Flood
Historical evidence indicates that Wendell is susceptible to flood events. No flood events have been reported by the National Climatic Data Center resulting in $0 in damages. On an annualized level, these damages amounted to $0 for Wendell.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for the county. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table K.42** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

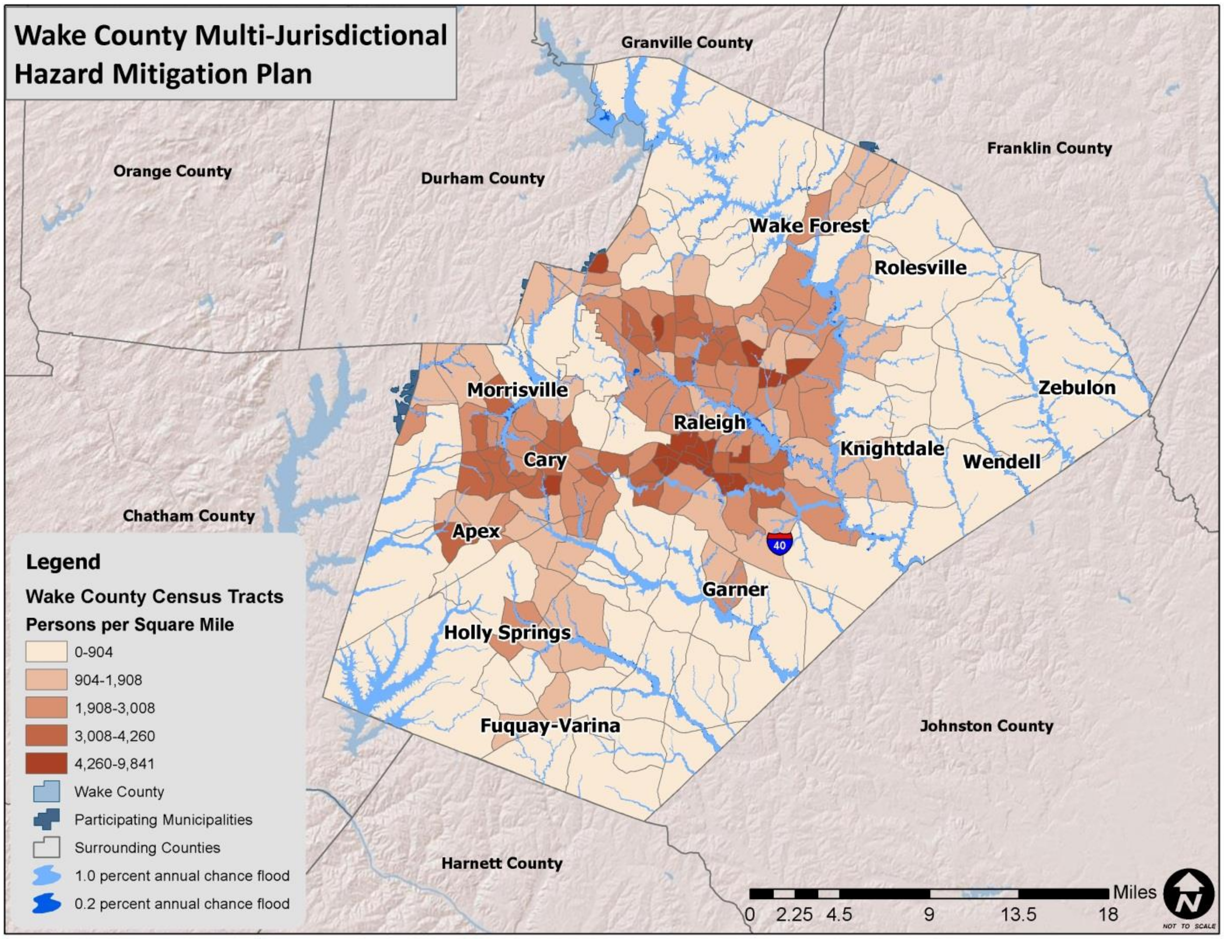
TABLE K.42: ESTIMATED EXPOSURE OF PARCELS TO THE FLOOD HAZARD

	1.0-percent ACF			0.2-percent ACF		
Location	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings
Wendell	80	2	$21,156,386	15	12	$1,039,584

Source: FEMA DFIRM

Social Vulnerability
Since 2010 population was available at the tract level, it was difficult to determine a reliable figure on population at-risk to flood due to tract level population data. **Figure K.12** is presented to gain a better understanding of at risk population.

FIGURE K.12 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities

The critical facility analysis revealed that there are a no critical facilities located in the Wendell 1.0-percent annual chance floodplain and 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. A list of specific critical facilities and their associated risk can be found in **Table K.48** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings and populations in Wendell, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

Hazardous Materials Incident

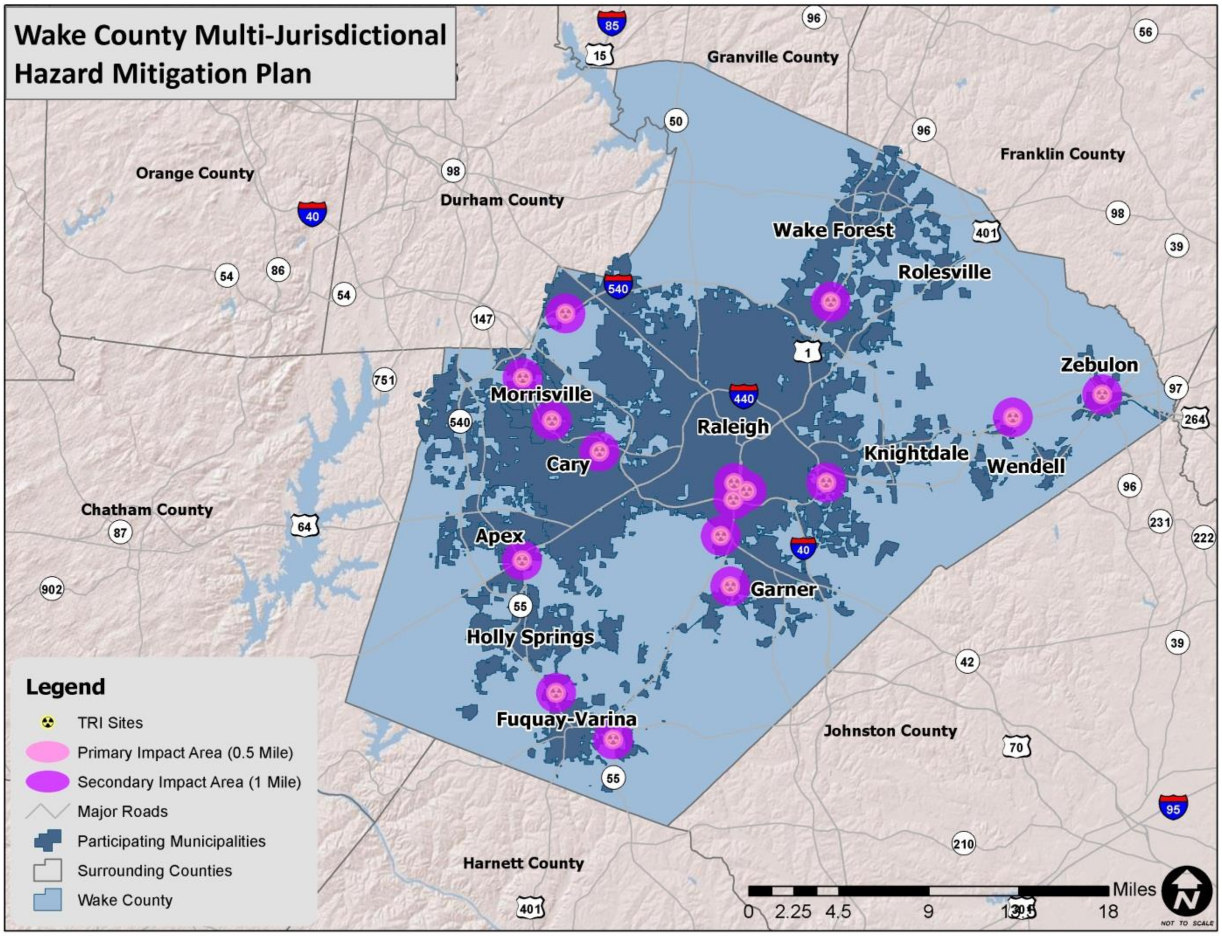
Although historical evidence and existing Toxic Release Inventory sites indicate that Wendell is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Wendell.

Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[19] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Wendell, along with buffers, were used for analysis as shown in **Figure K.13.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the GIS buffer analysis. **Figure K.14** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table K.43** (fixed sites), **Table K.44** (mobile road sites) and **Table K.45** (mobile railroad sites).[20]

[19] This type of analysis will likely yield inflated results (generally higher than what is actually reported after an event).
[20] Note that parcels included in the 1.0-mile analysis are also included in the 0.5-mile analysis.

FIGURE K.13 : TRI SITES WITH BUFFERS IN WENDELL



Source: EPA

TABLE K.43: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Wendell	19	18	$4,749,408	96	111	$30,683,271

FIGURE K.14 : MOBILE HAZMAT BUFFERS IN WENDELL

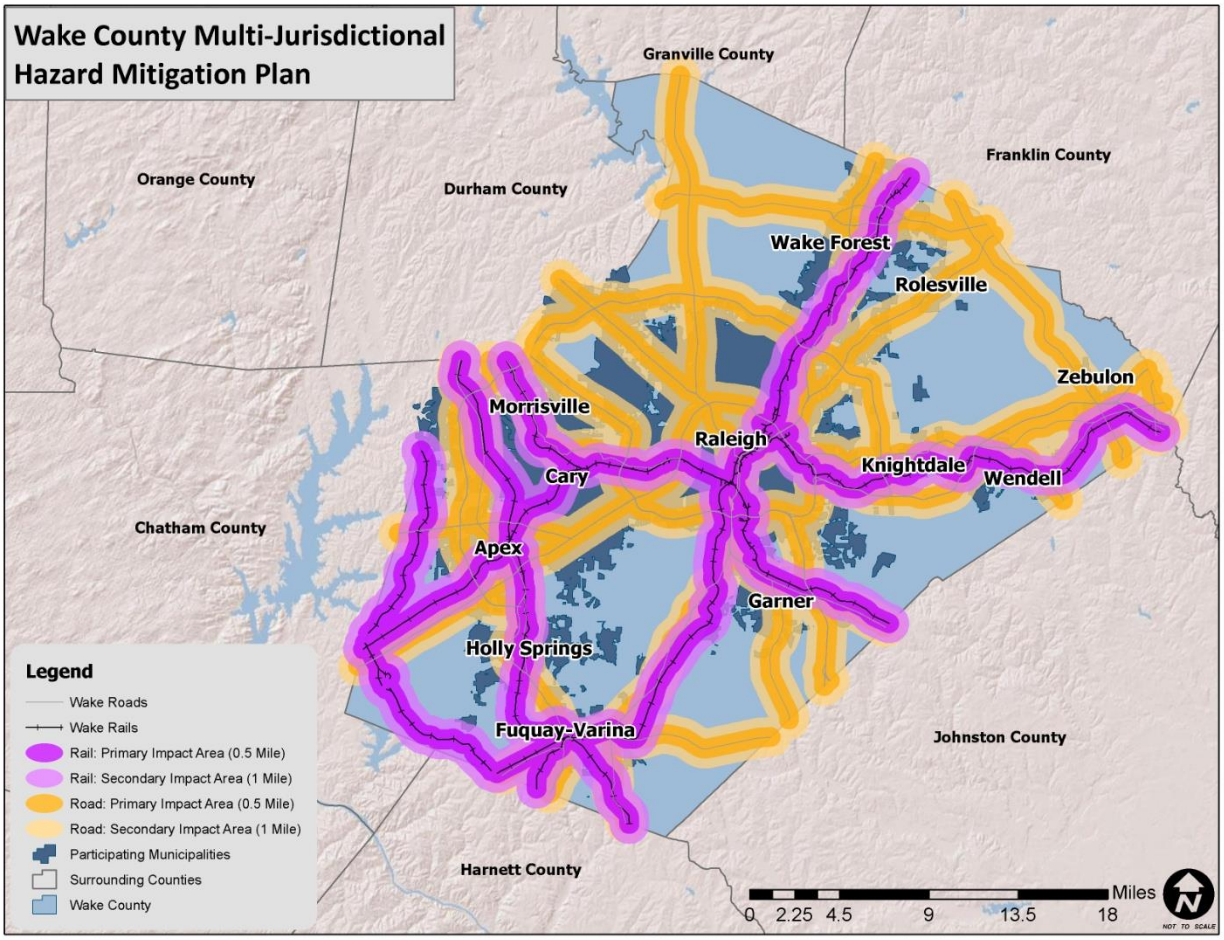


TABLE K.44: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Wendell	2,056	2,132	$250,377,132	2,525	2,571	$286,405,852

TABLE K.45: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Wendell	1,585	1,639	$175,138,028	2,349	2,343	$255,120,766

Social Vulnerability

Given high susceptibility across the jurisdiction, it is assumed that the total population is at risk to a hazardous materials incident. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities

Fixed Site Analysis:

The critical facility analysis for fixed TRI sites revealed that no critical facilities are located in a HAZMAT risk zone. A list of specific critical facilities and their associated risk can be found in **Table K.48** at the end of this section.

Mobile Analysis:

The critical facility analysis for road and railroad transportation corridors in Wendell revealed that there are 10 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 9 facilities. The remaining facility is in the secondary, 1.0-mile zone. The railroad buffer areas include 10 facilities with 7 in the primary impact zone. It should be noted that many of the facilities located in the buffer areas for railroad are also located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table K.48** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Wendell. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc. Further, incidents from neighboring jurisdictions could also have an impact.

Wildfire

Although historical evidence indicates that Wendell is susceptible to wildfire events, there are few reports of damage. Upon conversion of the wildfire risk data (see Section 6: *Vulnerability Assessment*) and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the jurisdiction should be assumed to be very low. As such, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the county.

Social Vulnerability

All areas have relatively equal vulnerability and there is low susceptibility across the entire county.
It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in wildfire areas of concern. It should be noted, however, that several factors could impact the spread of a wildfire putting all facilities at risk. A list of specific critical facilities and their associated risk can be found in **Table K.48** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Wendell.

Nuclear Accident
The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table K.46** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE K.46: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[21]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[22]
Wendell	0	0	$0	2,576	2,577	$287,227,420

Social Vulnerability
Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities
The critical facility analysis revealed that there are no critical facilities located in the 10-mile nuclear buffer area in Wendell.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in Wendell, though areas closer to the power plant are at a higher risk than others. All structures are at some risk given that they are all located within at least the 50-mile buffer area.

Conclusions on Hazard Vulnerability
Table K.47 presents a summary of annualized loss for each hazard in Wendell. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, although an annualized loss was determined through the damage reported through historical occurrences at the municipal level, it is likely that the county-wide

[21] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.
[22] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

estimate (found in Section 6: *Vulnerability Assessment*) is potentially a better estimate. These values should be used as an additional planning tool or measure risk for determining hazard mitigation strategies.

TABLE K.47: ANNUALIZED LOSS FOR WENDELL*

Event	Wendell
Dam Failure	Negligible
Drought	Negligible
Erosion	Negligible
Extreme Heat	Negligible
Hail	Negligible
Hurricane & Tropical Storm	Negligible
Landslide	Negligible
Lightning	$62,291
Thunderstorm Wind/High Wind[23]	$1,519
Tornado	$311,795
Winter Storm & Freeze	Negligible
Flood	Negligible
Earthquake	Negligible
HAZMAT Incident	Negligible
Wildfire	Negligible
Nuclear Accident	Negligible
Terror Threat	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table K.48** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

[23] The annualized losses for these hazards were combined.

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TABLE K.48: AT-RISK CRITICAL FACILITIES IN WENDELL

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER										
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
WENDELL																								
WENDELL	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WENDELL #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WENDELL TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
PUBLIC WORKS- WASTEWATER FACILITY	OTHER	X	X	X	X	X	X	X	X	X								X		X			X	X
CRESTFIELD APTS FOR DISABLED AND ELDERLY	OTHER	X	X	X	X	X	X	X	X	X							X	X		X			X	X
OLIVER HOUSE REST HOME	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
ROBINWOOD APARTMENTS- ELDERLY	OTHER	X	X	X	X	X	X	X	X	X							X	X		X			X	X
CEDAR SPRINGS APARTMENTS- ELDERLY	OTHER	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WENDELL	POLICE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
WENDELL ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
LAKE MYRA ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X

Secondary Critical Facilities are listed in slight contrast to Critical Facilities as their continued function has not been deemed as critical as primary facilities in the event of a disaster, but these facilities are extremely important. A loss of function to one of these facilities would have a definitively greater negative impact on the community's ability to respond to and recover from a disaster than a loss of function at other facilities/structures within the jurisdiction. In **Table K.49**, these facilities have been classified as either Significant Community Locations/Sheltering Centers or as Critical Resources Management Facilities. These facilities are all vulnerable to any of the atmospheric hazards and many are also likely vulnerable to other hazards identified above, though no locational analysis was carried out to this end.

TABLE K.49: WENDELL SECONDARY CRITICAL FACILITIES

Facility Name	Address*	Type
Wendell		
Wendell Community Center	601 W. Third Street	Significant Community Location or Sheltering Center
0.5 MGD Water Tank	Poplar Street	Critical Resources Management (Energy, Water, etc.)
0.75 MGD Water Tank	Chevrolet Way	Critical Resources Management (Energy, Water, etc.)
Water booster Pump Stations	• Liles Dean Road • Old Zebulon Road	Critical Resources Management (Energy, Water, etc.)
Water or Sewer Meter Stations		Critical Resources Management (Energy, Water, etc.)
Sanitary Sewer Pump Stations		Critical Resources Management (Energy, Water, etc.)
Waterlines		Critical Resources Management (Energy, Water, etc.)
Sewer lines		Critical Resources Management (Energy, Water, etc.)
Southern Bell	104 N. Pine Street	Critical Resources Management (Energy, Water, etc.)
Wendell Public Library	207 S. Hollybrook Rd	Significant Community Location or Sheltering Center
US Post Office	40 Hanor Ln	Significant Community Location or Sheltering Center
ABC Land Child Care I	610 Raymond Dr	Significant Community Location or Sheltering Center
ABC Land Child Care II	55 Liles Dean Rd	Significant Community Location or Sheltering Center
Eastern Wake Senior Center	323 Lake Drive	Significant Community Location or Sheltering Center
Parhams Day Care	4690 Wendell Blvd	Significant Community Location or Sheltering Center
Wendell Baptist Church Day Care	3651 Wendell Blvd	Significant Community Location or Sheltering Center
Wendell Commercial Historic District	Downtown Wendell	Significant Community Location or Sheltering Center

**Some address information could not be provided or was not applicable to the facility*

K.4 TOWN OF WENDELL CAPABILITY ASSESSMENT

This subsection discusses the capability of the Town of Wendell to implement hazard mitigation activities. More information on the purpose and methodology used to conduct the assessment can be found in Section 7: *Capability Assessment*.

K.4.1 Planning and Regulatory Capability

Table K.50 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the Town of Wendell. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE K.50: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning Tool/Regulatory Tool	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan (Parks & Rec/Greenway Plan	Stormwater Management Plan/Ordinance	Natural Resource Protection Plan	Flood Response Plan	Emergency Operations Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	National Flood Insurance Program (NFIP)	NFIP Community Rating System
Wendell	✓	✓		✓	✓			✓				✓	✓		✓	✓	✓	✓		✓	✓	✓	

A more detailed discussion on the town's planning and regulatory capabilities follows.

Emergency Management

Hazard Mitigation Plan
The Town of Wendell has previously adopted a hazard mitigation plan.

Emergency Operations Plan
The Town of Wendell has adopted the Wake County Emergency Operations Plan.

General Planning

Comprehensive Land Use Plan
The Town of Wendell has adopted the a comprehensive plan.

Capital Improvements Plan
The Town of Wendell has a capital improvement plan in place.

Zoning Ordinance
The Town of Wendell includes zoning regulations as part of the local unified development ordinance.

Subdivision Ordinance
The Town of Wendell also includes subdivision regulations as part of the local unified development ordinance.

Building Codes, Permitting, and Inspections
North Carolina has a state compulsory building code which applies throughout the state. Wake County provides building inspections through contractual agreement for the Town of Wendell.

Floodplain Management

Table K.51 provides NFIP policy and claim information for the Town of Wendell.

TABLE K.51: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
Wendell	06/01/78	04/16/07	13	$3,155,000	6	$77,232

Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Flood Damage Prevention Ordinance
All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. The Town of Wendell participates in the NFIP and has adopted flood damage prevention regulations.

Open Space Management Plan
The Town of Wendell has adopted the *Zebulon and Wendell Open Space and Greenway Plan*.

Stormwater Management Plan
The Town of Wendell has not adopted a stormwater management plan; however, the town includes stormwater management regulations as part of the local unified development ordinance.

K.4.2 Administrative and Technical Capability

Table K.52 provides a summary of the capability assessment results for the Town of Wendell with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in the town with the specified knowledge or skill.

TABLE K.52: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	Planners with knowledge of land development/land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency Manager	Floodplain Manager	Land Surveyors	Scientists familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Resource development staff or grant writers
Wendell	✓	✓	✓	✓	✓		✓	✓	✓	

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

K.4.3 Fiscal Capability

Table K.53 provides a summary of the results for the Town of Wendell with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plan.

TABLE K.53: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes (or taxing districts)	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.
Wendell	✓	✓	✓						✓	✓

K.4.4 Political Capability

The previous hazard mitigation plan indicates that the officials, staff, and residents of the Town of Wendell are very supportive of mitigation efforts. They foresee significant development in the future and understand the importance that the town be developed in a manner which reduces the possibility of impacts from natural disasters. This attitude toward mitigation measures is expected to continue in the future, even as mayors and town commissioners change.

K.4.5 Conclusions on Local Capability

Table K.54 shows the results of the capability assessment using the designed scoring methodology described in Section 7: *Capability Assessment*. The capability score is based solely on the information found in existing hazard mitigation plan and readily available on the town's government website. According to the assessment, the local capability score for the town is 39, which falls into the moderate capability ranking.

TABLE K.54: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
Wendell	39	Moderate

K.5 TOWN OF WENDELL MITIGATION STRATEGY

This subsection provides the blueprint for Wendell to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Regional Work Groups and the findings and conclusions of the capability assessment and risk assessment. Additional Information can be found in Section 8: *Mitigation Strategy* and Section 9: *Mitigation Action Plan*.

K.5.1 Mitigation Goals

Wendell developed seven mitigation goals in coordination with Wake County and the other participating municipalities. The county-wide mitigation goals are presented in **Table K.55**.

TABLE K.55: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

K.5.2 Mitigation Action Plan

The mitigation actions proposed by Wendell are listed in the following Mitigation Action Plan.

Town of Wendell Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Prepare Hazard Mitigation Plan Update.	All	High	Wendell Advisory Committee	Internal	Completed	This is in the process currently. This action will be removed from the next update.
P-2	Prepare Multi-Jurisdictional Hazard Mitigation Plan.	All	High	Atkins and Participating Jurisdictions	Wake County Grant	August 2014	This is in the process currently. This action will be removed from the next update.
P-3	Adopt Hazard Mitigation Plan Update.	All	High	Wendell Town Board of Commissioners	Internal	Upon approval of Hazard Mitigation Plan by FEMA	Upon 2014 approval of Hazard Mitigation Plan by FEMA. This is in the process currently. This action will be removed from the next update.
P-4	Prepare Plan Maintenance Report.	All	High	Wendell Planning	Internal	Annually	This action will be removed from the next update as it is done annually.
P-5	Prepare updates to Plan.	All	High	Wendell Planning	Internal	As needed	This is in the process currently. This action will be removed from the next update.
P-6	Revise Hazard Mitigation Plan.	All	High	Wendell Advisory Committee	Internal	Every five years	Town is participating in Multi-jurisdictional HMP. This is in the process currently. This action will be removed from the next update.
P-7	Keep evacuation routes open.	All	High	Wendell Public Works and Public Safety	Internal	Completed	Evacuation routes have been established and are maintained. This is in the process currently. This action will be removed from the next update.
P-8	Maintain trees adjacent to power lines and critical facilities.	All	High	Wendell Public Works and Progress Energy	Internal and Private	Completed	Trees adjacent to power lines and critical facilities have been maintained and will continue to be monitored. This is in the process currently. This action will be removed from the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-9	Maintain water supply system.	All	High	City of Raleigh Public Utilities	Internal	Completed	City of Raleigh Public Utility crews provide system maintenance per routine schedules. This action will be removed in the next update as a capability.
P-10	Maintain sewer lift stations, including generators.	All	High	City of Raleigh Public Utilities	Internal	Completed	City of Raleigh Public Utility crews provide system maintenance per routine schedules. This action will be removed in the next update as a capability.
P-11	Install generators as needed at lift stations.	All	High	City of Raleigh Public Utilities	Internal	2019	Generators have been installed at several lift stations, but more may be necessary looking forward. This will be evaluated and additions will be made as deemed appropriate.
P-12	Maintain Storm Drainage system.	Flood	High	Wendell Public Works	Internal	Completed	The storm drainage system is maintained. This action will be removed in the next update as a capability.
P-13	Enforce subdivision standards for development in flood hazard areas.	Flood	High	Wendell Planning and Inspections	Internal	Completed	Subdivision standards restricting development in the floodplain are in force. This action will be removed in the next update as a capability.
P-14	Further restrict development in floodplain by prohibiting development.	Flood	High	Wendell Planning	Internal	Completed	Development is prohibited in the floodplain. Implemented through UDO. This action will be removed in the next update as a capability.
P-15	Require burial of power lines for new developments.	Hurricanes, Tornadoes, Winter Storms/ Freezes	Moderate	Wendell Planning	Private	Completed	A requirement for burying power lines is in place. This action will be removed in the next update as a capability.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-16	Require new construction to comply with wind section of Building Code.	Hurricanes, Tornadoes	High	Wendell Inspections	Internal	Completed	New construction must comply with the wind section of the building code. This action will be removed in the next update as a capability.
P-17	Include flood map data on GIS system.	All	Moderate	Wendell Planning	Internal	2019	Flood map data is included on the GIS system. However, this data will need to be updated as new flood information is made available.
Natural Resource Protection							
NRP-1	Maintain and expand greenway system, stream buffers.	Flood	Low	Wendell Parks and Recreation	Internal, Private Developers	2018	Seeking funding and easements started in 2013. This action has begun, but it is not yet completed.
Emergency Services							
ES-1	Implement Disaster Notification Policy.	All	High	Wendell Public Safety	Internal	Completed	This policy has been implemented. This action will be removed in the next update as a capability.
ES-2	Adhere to Disaster Notification Policy.	All	High	Wendell Public Safety	Internal	Completed	This policy has been implemented. This action will be removed in the next update as a capability.
ES-3	Implement Community Center Use Policy.	All	High	Wendell Parks and Recreation	Internal	Completed	This policy has been implemented. This action will be removed in the next update as a capability.
ES-4	Adhere to Community Center Use Policy.	All	High	Wendell Parks and Recreation	Internal	Completed	This policy has been implemented. This action will be removed in the next update as a capability.
ES-5	Review Inclement Weather Policy.	All	High	Wendell All Departments	Internal	2018	The Inclement Weather Policy is in place and will continue to be utilized. However, the policy will need to be reviewed and updated.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-6	Adhere to Snow and Debris Removal Policy.	Hurricanes, Tornadoes, Winter Storms/ Freezes	High	Wendell Administration and Public Works	Internal	Completed	This policy has been implemented. This action will be removed in the next update as a capability.
ES-7	Adhere to debris removal and disposal plan.	Hurricanes, Tornadoes, Severe Winter Storms	Moderate	Wendell Administration and Public Works	Internal and Possible Grant	Completed	This policy has been implemented. This action will be removed in the next update as a capability.
Public Education and Awareness							
PEA-1	Provide links to hazard notices on Town website.	All	Moderate	Wendell Town Web Administrator	Internal	Completed	Hazard notices are posted on the town website when events occur. This will continue going forward.
PEA-2	Inform public of construction requirements in hazard areas.	Flood	Moderate	Wendell Building, Inspections	Internal	2015	Materials have been developed to inform the public of construction requirements in hazard areas, but this material requires updating.
PEA-3	Require disclosure of flood hazard in real estate transactions.	Flood	Moderate	Wendell Planning	Internal	Deleted	Delete – not feasible to be involved in real estate transactions
PEA-4	Make FEMA manuals available to residents.	All	Moderate	Wendell Planning	Internal	2015, annual review and update	FEMA manuals have been made available to residents in the past, but new materials are consistently being developed so the town will need to review and update materials annually.
PEA-5	Present Plan at public meeting.	All	Moderate	Wendell Planning	Internal	Completed	Complete New Target Date September 2014. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-6	Post plan maintenance report for public comment.	All	Moderate	Wendell Town Manager	Internal	Completed	Plan maintenance report was posted for viewing by the public. This action will be removed in the next update.
PEA-7	Post copy of approved Plan in Town Hall.	All	Moderate	Wendell Planning	Internal	Completed	A copy of the plan was posted at Town Hall. This will be done with the new plan update as well. This action will be removed in the next update.
PEA-8	Provide links to flood warnings, hurricane tracks, tornado and severe thunderstorm warnings, winter storm warnings, and drought/heat wave information on website.	Flood, Hurricane and Tropical Storms, Tornadoes, Severe Thunderstorm, Drought, Heat Wave	Low	Wendell Town Web Administrator	Internal	2018	Links are provided on the website for these items but will need to be updated.
PEA-9	Make flood maps available to the public.	Flood	Moderate	Wendell Planning	Internal	Completed	Flood maps are available to the public via a number of channels. This action will be removed in the next update.
PEA-10	Post water restrictions and tips for reducing water consumption on website, within Town Hall, and on local access television station.	Drought/Heat Wave	Moderate	Wendell Public Works	Internal	Completed	Tips on water restrictions and for reducing consumption have been displayed online. This action will be removed in the next update.
PEA-11	Keep website updated with latest storm and emergency response information.	All	Low	Wendell Web Administrator	Internal	Completed	The town has website updated and available to keep public informed in case of emergencies

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-12	Inform public about flood mitigation techniques (i.e., remove debris from storm drains prior to large storm event).	Flood, Hurricane and Tropical Storms, Severe Thunderstorm	Moderate	Wendell Public Works	Internal	2017	New action

Annex L
Town of Zebulon

This annex includes jurisdiction-specific information for the Town of Zebulon. It consists of the following five subsections:

- L.1 Town of Zebulon Community Profile
- L.2 Town of Zebulon Risk Assessment
- L.3 Town of Zebulon Vulnerability Assessment
- L.4 Town of Zebulon Capability Assessment
- L.5 Town of Zebulon Mitigation Strategy

L.1 TOWN OF ZEBULON COMMUNITY PROFILE

L.1.1 Geography and the Environment

Zebulon is town located in Wake County in the state of North Carolina. It was incorporated in 1907 and named after Zebulon Baird Vance who was governor of North Carolina during the Civil War.

Overall, Wake County is known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Summer temperatures generally venture into the 90s for highs and cool off to the 70s at night. Winter temperatures in can drop to below freezing but generally highs are in the 50s. Rainfall is most common in the summer months but occurs consistently throughout the year.

L.1.2 Population and Demographics

According to the 2010 Census, Zebulon has a population of 4,433 people. The jurisdiction has seen exceptional growth between 2000 and 2010, and the population density is around 1,100 people per square mile. Population counts from the US Census Bureau for 1990, 2000, and 2010 are presented in **Table L.1**.

TABLE L.1: POPULATION COUNTS FOR ZEBULON

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
ZEBULON	3,173	4,046	4,433	9.57%

Source: US Census Bureau

The racial characteristics of the jurisdiction are presented in **Table L.2**. No single race makes up a majority in the jurisdiction as whites account for around 47 percent of the population, with blacks accounting for nearly 39 percent of the population.

TABLE L.2: DEMOGRAPHICS OF ZEBULON

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
ZEBULON	47.3%	38.6%	0.5%	13.6%	14.3%

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

L.1.3 Housing

According to the 2010 US Census, there are 1,862 housing units in Zebulon, the majority of which are single family homes or mobile homes. Housing information for the jurisdiction is presented in **Table L.3**.

TABLE L.3: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Seasonal Units, Percent (2010)	Median Home Value (2006-2010)
ZEBULON	1,661	1,862	11.1%	$110,400

Source: US Census Bureau

L.1.4 Infrastructure

Transportation
There are several major roadways that residents of Zebulon utilize. The most prominent is Interstate 40 which runs through the county on an east-west track and has two spurs (I-440 and I-540/NC-540). However, Zebulon is served primarily by US-264 which connects the jurisdiction to many of the other municipalities. In addition, there are many major highways that residents of the municipality utilize. Federal highways of note are US-1, US-64, US-70, and US-401, while state highways in the include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities
Electrical power in the jurisdiction is provided by two entities and Duke Energy and Wake Electric Membership Corporation with Duke Energy providing service to a majority of the service. Water and sewer service is provided by two main entities as well: The City of Raleigh Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

Community Facilities

There are a number of buildings and community facilities located throughout Zebulon. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 1 fire station, 1 police station, and 3 public schools located within the county.

Citizens also have access to several parks, including three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the county, including the American Tobacco Trail which is a rails to trails project that is open to a wide variety of non-motorized uses.

L.1.5 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land as parks. There are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the jurisdiction consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

L.1.6 Employment and Industry

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

L.2 TOWN OF ZEBULON RISK ASSESSMENT

This subsection includes hazard profiles for each of the significant hazards identified in Section 4: *Hazard Identification* as they pertain to Zebulon. Each hazard profile includes a description of the hazard's location and extent, notable historical occurrences, and the probability of future occurrences. Additional information can be found in Section 5: *Hazard Profiles*.

L.2.1 Drought

Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, Zebulon has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that the county would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Historical Occurrences

According to the North Carolina Drought Monitor, Zebulon has had drought occurrences all of the last fourteen years (2000-2013). **Table L.4** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE L.4: HISTORICAL DROUGHT OCCURRENCES IN ZEBULON

Abnormally Dry | **Moderate Drought** | **Severe Drought** | **Extreme Drought** | **Exceptional Drought**

	Zebulon
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that Zebulon has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

L.2.2 Extreme Heat

Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to any geographic or political boundaries. All of Zebulon is susceptible to extreme heat conditions.

Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Zebulon. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the region. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the county. The most centralized location is in Raleigh at North Carolina State University. **Table L.5** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table L.5: Average Maximum Temperature in Raleigh, Wake County

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

L.2.3 Hailstorm

Location and Spatial Extent

Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Zebulon is uniformly exposed to severe thunderstorms; therefore, all areas are equally exposed to hail which may be produced by such storms.

Historical Occurrences

According to the National Climatic Data Center, 6 recorded hailstorm events have affected Zebulon since 1993.[1] **Table L.6** is a summary of the hail events in Zebulon. **Table L.7** provides detailed information about each event that occurred. In all, hail occurrences resulted in $0 (2013 dollars) in property damages. Hail ranged in diameter from 0.75 inches to 1.75 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value.

Table L.6: Summary of Hail Occurrences in Zebulon

Location	Number of Occurrences	Property Damage (2013)
Zebulon	6	$0

Source: National Climatic Data Center

[1] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Zebulon. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

TABLE L.7: HISTORICAL HAIL OCCURRENCES IN ZEBULON

	Date	Magnitude	Deaths/Injuries	Property Damage*
Zebulon				
Zebulon	5/26/1995	0.75 in.	0/0	$0
ZEBULON	5/24/1996	1 in.	0/0	$0
ZEBULON	6/3/1998	0.75 in.	0/0	$0
ZEBULON	6/1/2002	1.75 in.	0/0	$0
ZEBULON	3/28/2005	0.75 in.	0/0	$0
ZEBULON	5/25/2006	0.88 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences
Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that Zebulon has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the county.

L.2.4 Hurricane and Tropical Storm

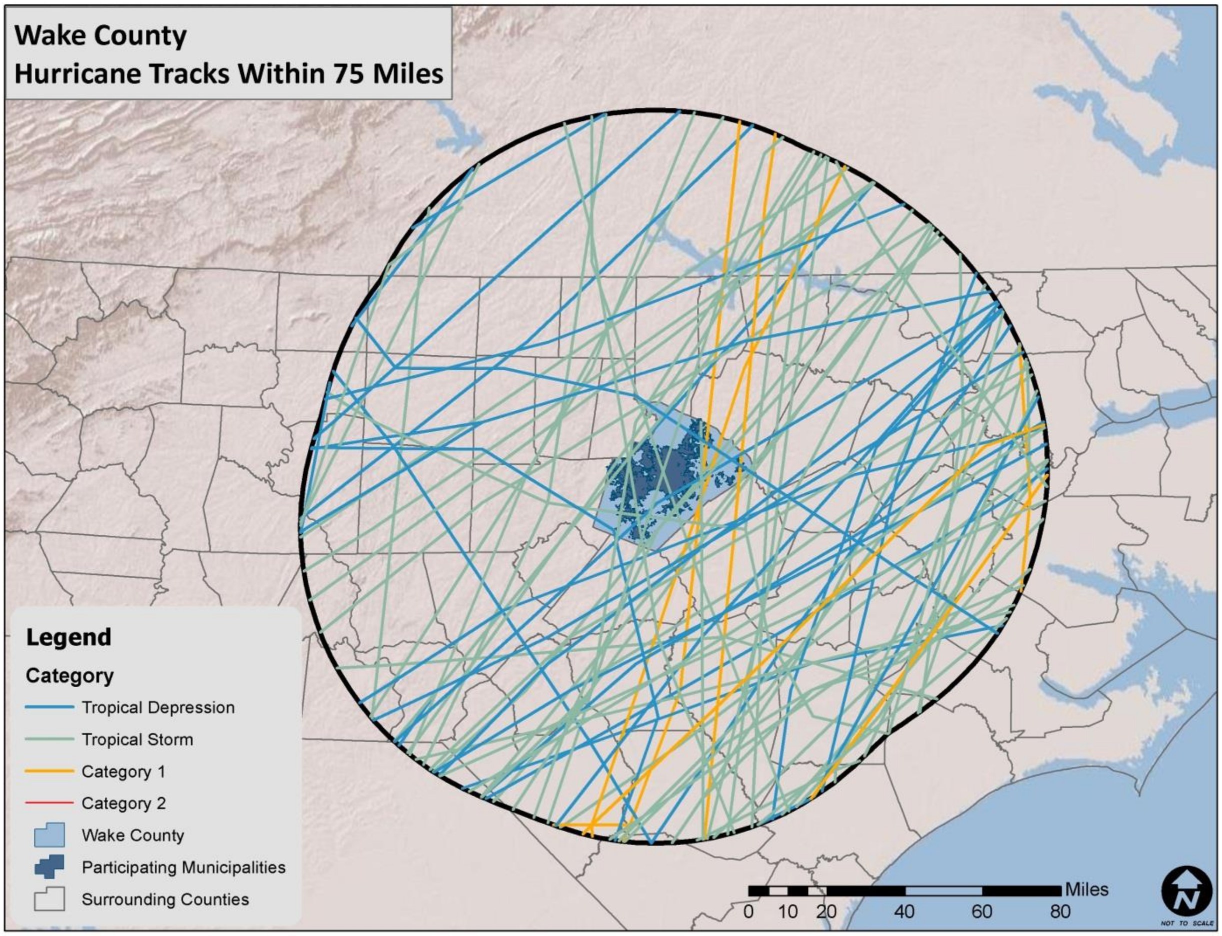
Location and Spatial Extent
Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Zebulon. The entire jurisdiction is equally susceptible to hurricane and tropical storms.

Historical Occurrences
According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[2] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms have traversed directly through Wake County as shown in **Figure L.1**. **Table L.8** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

[2] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

FIGURE L.1: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE L.8: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1
1882	NOT NAMED	53	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm
1959	CINDY	26	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression
2008	HANNA	40	Tropical Storm

Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Zebulon between 1950 and 2013. These storms are listed in **Table L.9** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE L.9: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made in 1996 (Hurricane Fran), 1999 (Hurricane Floyd), and 2003 (Hurricane Isabel) for the county.[3]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Tropical Storm Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

Probability of Future Occurrences
Given the inland location of the jurisdiction, it is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Zebulon. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the jurisdiction is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

[3] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

L.2.5 Lightning

Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Zebulon is uniformly exposed to lightning.

Historical Occurrences

According to the National Climatic Data Center, there have been no recorded lightning events in Zebulon since 1950, as listed in summary **Table L.10** and detailed in **Table L.11**.[4] However, it is certain that more lightning events have in fact impacted the jurisdiction. Many of the reported events are those that caused damage, and it should be expected that damages are likely much higher for this hazard than what is reported.

TABLE L.10: SUMMARY OF LIGHTNING OCCURRENCES IN ZEBULON

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Zebulon	0	0/0	$0

Source: National Climatic Data Center

TABLE L.11: HISTORICAL LIGHTNING OCCURRENCES IN ZEBULON

	Date	Deaths/Injuries	Property Damage*	Details
Zebulon				
None reported				

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Although there were not a high number of historical lightning events reported in Zebulon via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S. National Lightning Detection Network (NLDN®), Zebulon is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the jurisdiction.

L.2.6 Severe Thunderstorm/High Wind

Location and Spatial Extent

A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Zebulon. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

favorable for generating these powerful storms. Also, Zebulon typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Zebulon has uniform exposure to an event and the spatial extent of an impact could be large.

Historical Occurrences

Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011.[5] According to NCDC, there have been 4 reported thunderstorm/high wind events since 1994 for high wind and since 1950 for thunderstorms.[6] These events caused over $40,283 (2013 dollars) in damages. **Table L.12** summarizes this information. **Table L.13** presents detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event.[7]

TABLE L. 12: SUMMARY OF THUNDERSTORM/HIGH WIND OCCURRENCES IN ZEBULON

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Zebulon	4	0/0	$40,283

Source: National Climatic Data Center

TABLE L.13: HISTORICAL THUNDERSTORM/HIGH WIND OCCURRENCES IN ZEBULON

	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Zebulon					
ZEBULON	5/1/1997	TSTM WIND	50 kts.	0/0	$32,404
ZEBULON	6/2/1997	TSTM WIND	50 kts.	0/0	$0
ZEBULON	3/8/2005	TSTM WIND	50 kts.	0/0	$0
ZEBULON	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$7,879

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire jurisdiction.

L.2.7 Tornado

Location and Spatial Extent

Tornadoes occur throughout the state of North Carolina, and thus in Zebulon. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Zebulon is uniformly exposed to this hazard.

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[5]A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional thunderstorm events have occurred in Zebulon. As additional local data becomes available, this hazard profile will be amended.
[7] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

Historical Occurrences

Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there has been one recorded tornado event in Zebulon since 1956 (**Table L.14**), resulting in $0 (2013 dollars) in property damages.[8] Detailed information on this event can be found in **Table L.15**. The magnitude of this tornado was a F0 in intensity, although an F5 event is possible. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is likely that a high number of occurrences have gone unreported over the past 50 years.

TABLE L.14: SUMMARY OF TORNADO OCCURRENCES IN ZEBULON

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Zebulon	1	0/0	$0

Source: National Climatic Data Center

TABLE L.15: HISTORICAL TORNADO IMPACTS IN ZEBULON

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Zebulon					
ZEBULON	9/18/2012	F0	0/0	$0	EPISODE NARRATIVE: Multiple line segments of strong to severe storms developed over North Carolina as a compact but potent shortwave emanating from the gulf coast region and along the eastern flanks of a full latitude trough moved through the Carolinas. The accompanying 50 to 60 knot mid level jet within a moist and unstable air mass produced scattered thunderstorm wind damage and an isolated EF-0 tornado near Zebulon.

*Property Damage is reported in 2013 dollars.
Source: NCDC

2011 Tornadoes- April 16, 2011

In 2011, the county and all of its jurisdictions were impacted by one of the worst tornado-related events in the county's recorded history. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries.

8 These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Zebulon. As additional local data becomes available, this hazard profile will be amended.

Probability of Future Occurrences

According to historical information, tornado events are not an annual occurrence for the jurisdiction. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Zebulon experience a direct tornado strike. The probability of future tornado occurrences affecting Zebulon is likely (10-100 percent annual probability).

L.2.8 Winter Storm and Freeze

Location and Spatial Extent

Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Zebulon is accustomed to smaller scale severe winter weather conditions and often receives severe winter weather during the winter months. Given the atmospheric nature of the hazard, the entire jurisdiction has uniform exposure to a winter storm.

Historical Occurrences

Severe winter weather has resulted in six disaster declarations in Zebulon. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. [9] According to the National Climatic Data Center, there have been no recorded winter storm events in Zebulon since 1993 (**Table L.16**).[10] These events resulted in $0 (2013 dollars) in damages. However, there have been 28 recorded countywide events and most severe winter weather events are only recorded at the county level.

TABLE L.16: SUMMARY OF WINTER STORM EVENTS IN ZEBULON

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Zebulon	0	0/0	$0

Source: National Climatic Data Center

There have been several severe winter weather events in Zebulon. The text below describes one of the major events and associated impacts on the county. Similar impacted can be expected with severe winter weather.

1996 Winter Storm

This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and

[9] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.

[10] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional winter storm conditions have affected Zebulon.

power outages. Furthermore, citizens may resort to using inappropriate heating devices that could to fire or an accumulation of toxic fumes.

Probability of Future Occurrences

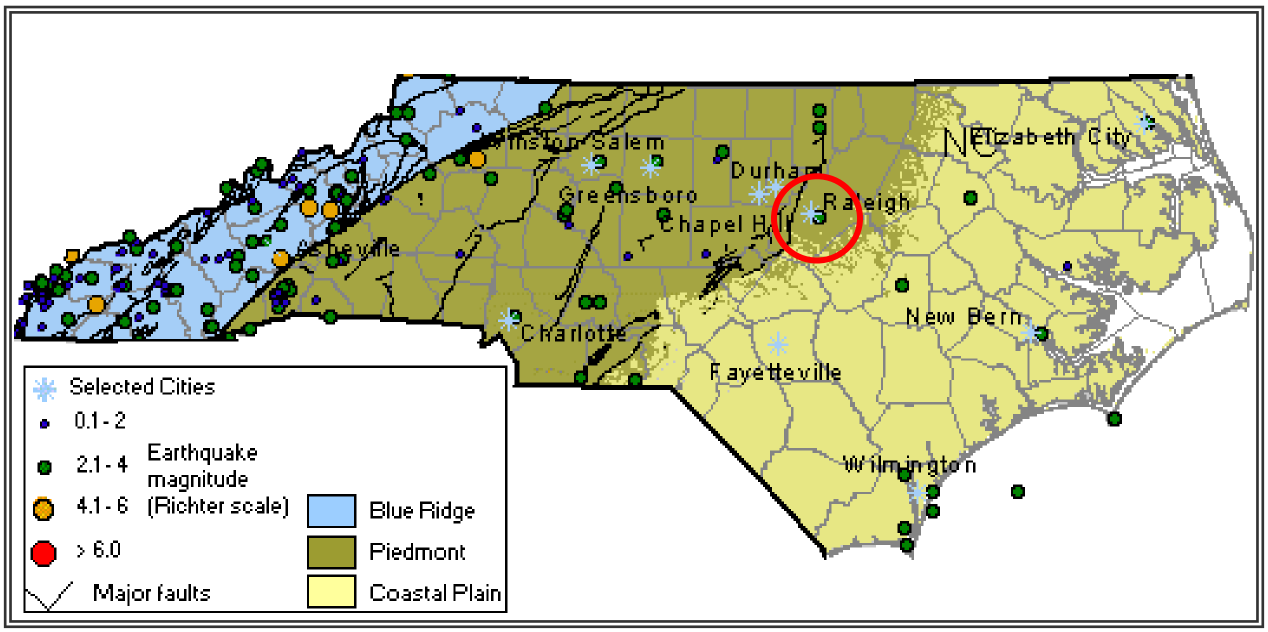
Winter storm events will remain a somewhat regular occurrence in Zebulon due to location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

L.2.9 Earthquake

Location and Spatial Extent

Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina. **Figure L.2** is a map showing geological and seismic information for North Carolina.

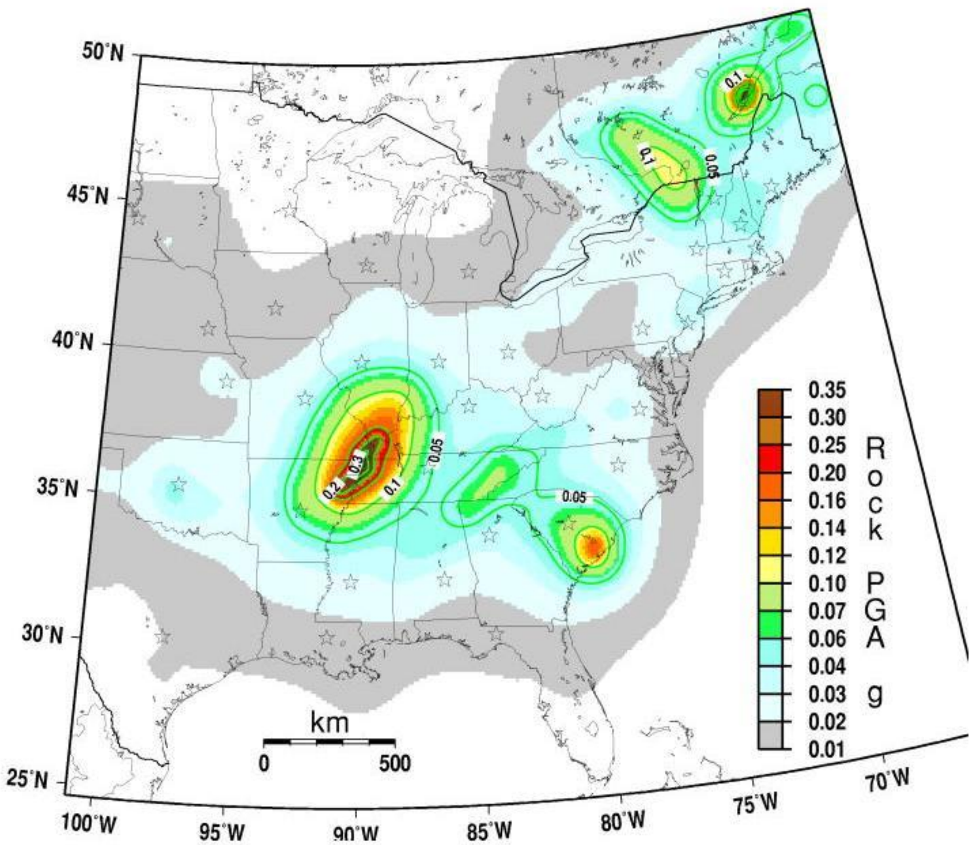
FIGURE L.2: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure L.3 shows the intensity level associated with Zebulon, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Zebulon lies within an approximate zone of level "2" to "3" ground acceleration. This indicates that the county exists within an area of moderate seismic risk.

FIGURE L.3: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

Historical Occurrences

Although no earthquakes are known to have occurred directly in Zebulon since 1874, several have occurred in the county and affected the municipality. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table L.17** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table L.18** presents a detailed occurrence of each event including the date, distance for the epicenter, and Modified Mercalli Intensity (if known). [11]

TABLE L.17: SUMMARY OF SEISMIC ACTIVITY IN ZEBULON

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Zebulon	--	--	--

Source: National Geophysical Data Center

[11] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

TABLE L.18: SIGNIFICANT SEISMIC EVENTS IN ZEBULON (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI (magnitude)
Zebulon				
None reported				

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Zebulon, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table L.19.**

TABLE L.19: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 - 1	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928*	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957*	Buncombe County, NC	3.7	VI	VI
11/24/1957*	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973*	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Zebulon occurrences.

** Conflicting reports on this event, intensity in North Carolina could have been either V or VI

Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Zebulon is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. The annual probability level for the county is estimated between 1 and 10 percent (possible).

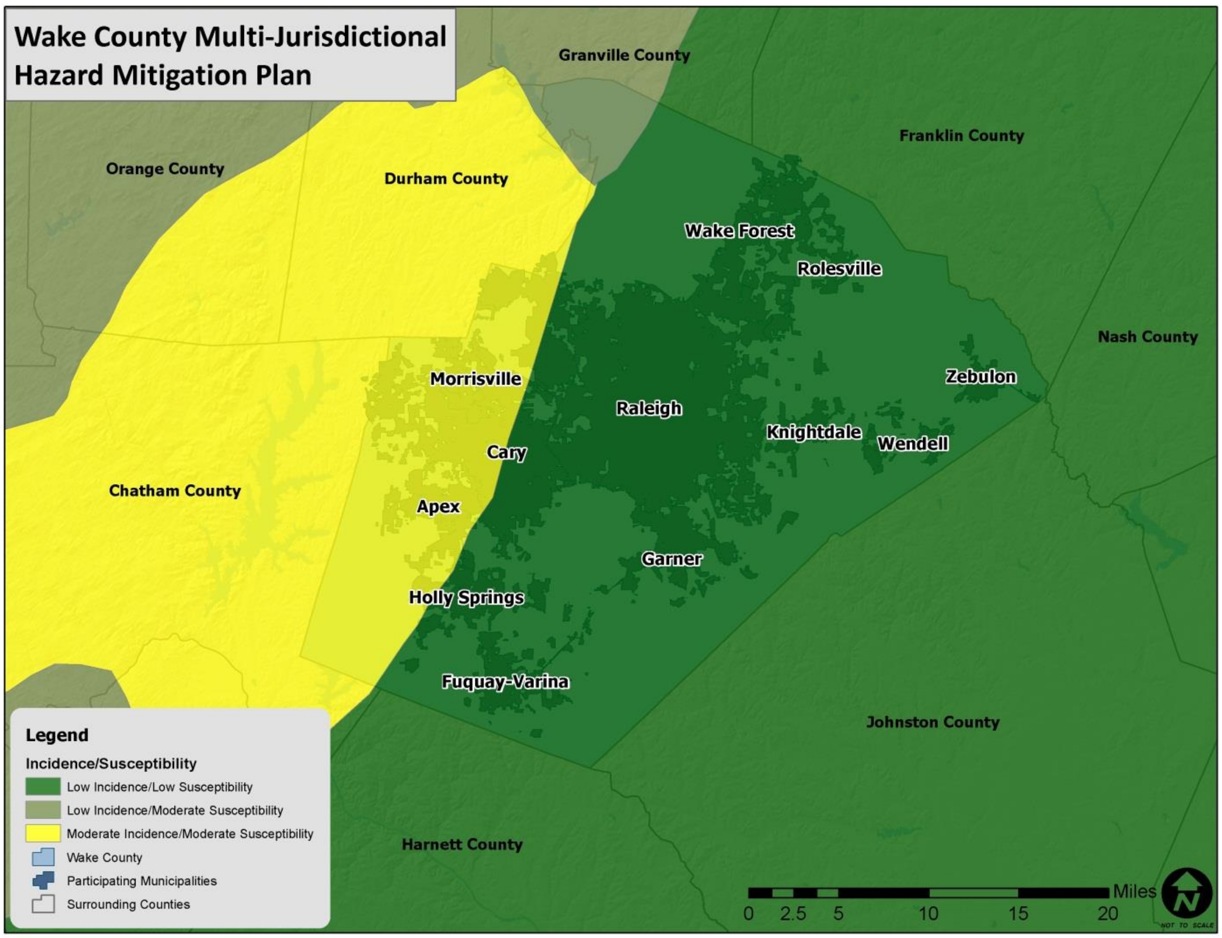
L.2.10 Landslide

Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Zebulon, although the overall risk is relatively low.

According to **Figure L.4** below, the majority of the county has low landslide activity. However there is a small area along the western border of the county that has a moderate incidence and moderate susceptibility. In all other areas (including all of Zebulon), there is low susceptibility.

FIGURE L.4: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

Historical Occurrences

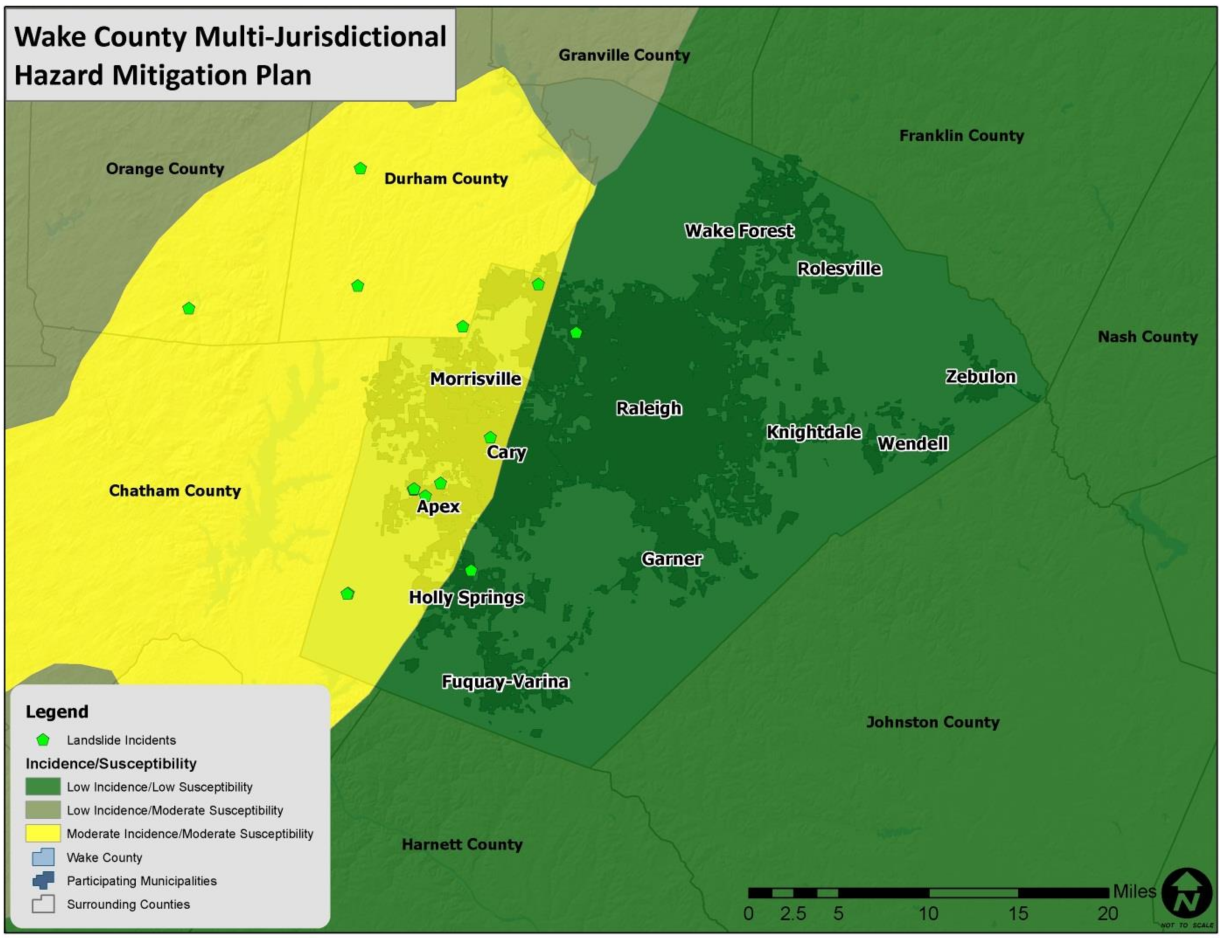
Steeper topography in some areas of Zebulon make the planning area susceptible to landslides. Most landslides are caused by heavy rainfall in the area. Building on steep slopes that was not previously possible also contributes to risk. **Table L.20** presents a summary of the landslide occurrence events as provided by the North Carolina Geological Survey[12]. The georeferenced locations of the landslide events presented in the aforementioned tables are presented in **Figure L.5**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred in Zebulon.

TABLE L.20: SUMMARY OF LANDSLIDE ACTIVITY IN ZEBULON

Location	Number of Occurrences
Zebulon	0

Source: North Carolina Geological Survey

FIGURE L.5: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for

[12] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Zebulon have greater risk than others given factors such as steepness on slope and modification of slopes.

L.2.11 Dam and Levee Failure

Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table L.21** explains these classifications.

TABLE L.21: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

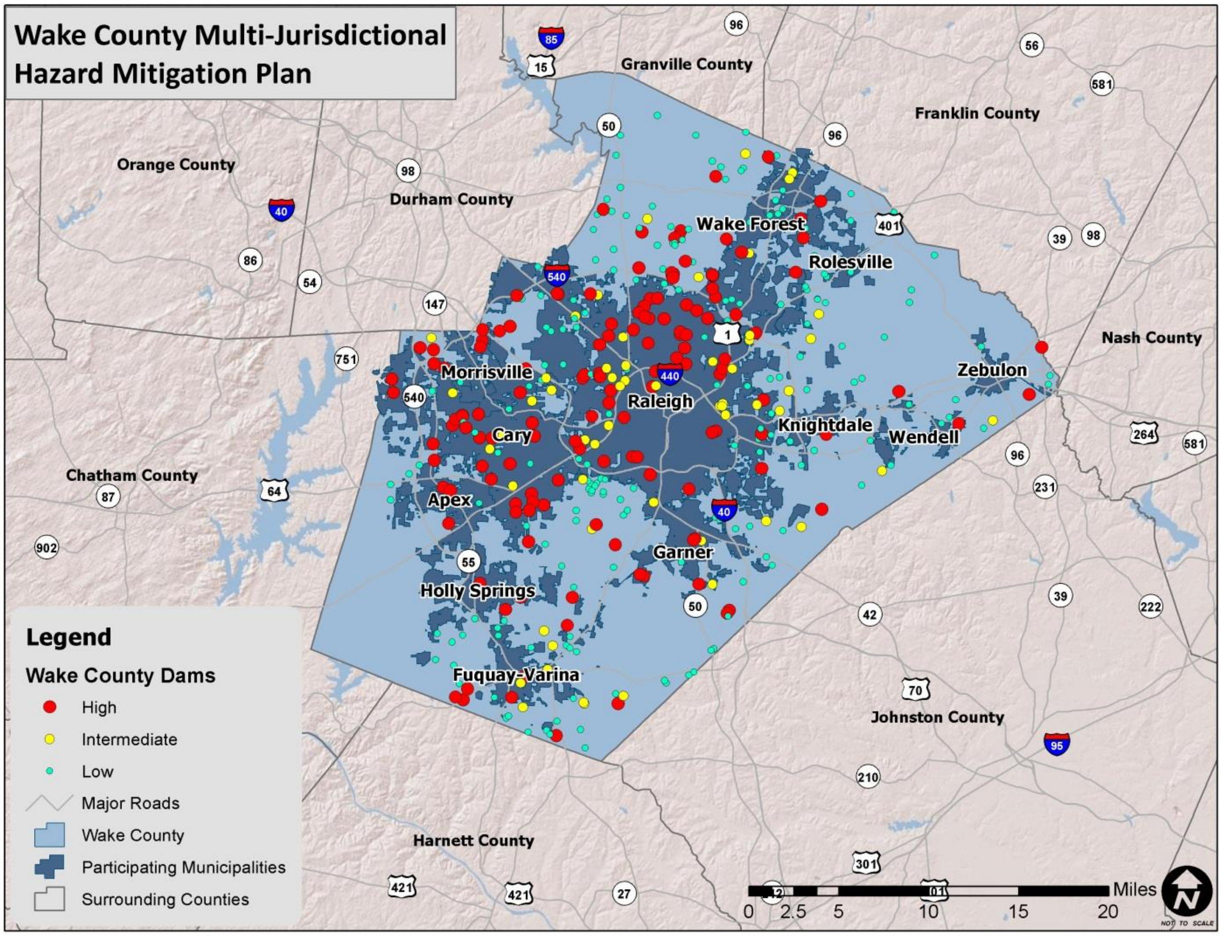
Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

According to the North Carolina Division of Land Management there is 1 dam in Zebulon.[13] **Figure L.6** shows the dam location and the corresponding hazard ranking for each. This dam is not classified as high hazard potential. High hazard dams are listed in **Table L.22**.

[13] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE L.6: WAKE COUNTY DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE L.22: ZEBULON HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Zebulon				
None reported				

Source: North Carolina Division of Land Resources, 2012

It should also be noted that the North Carolina dam classification regulations were recently updated. As a result of the change, more dams are generally classified as high hazard.

Historical Occurrences

One dam breach was reported in Zebulon in 1996 during Hurricane Fran at Penny Hill Lake.

Probability of Future Occurrences

Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

L.2.12 Erosion

Location and Spatial Extent

Erosion in Zebulon is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Zebulon soils have greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Zebulon, particularly along the banks of rivers and streams, but it is not an extreme threat. No areas of concern were reported by the planning committee.

Historical Occurrences

Several sources were vetted to identify areas of erosion in Zebulon. This includes searching local newspapers, interviewing local officials, and reviewing the previous hazard mitigation plan. Little information could be found and erosion was not addressed in the previous Zebulon hazard mitigation plan.

Probability of Future Occurrences

Erosion remains a natural, dynamic, and continuous process for Zebulon, and it will continue to occur. The annual probability level assigned for erosion is possible (between 1 and 10 percent annually).

L.2.13 Flood

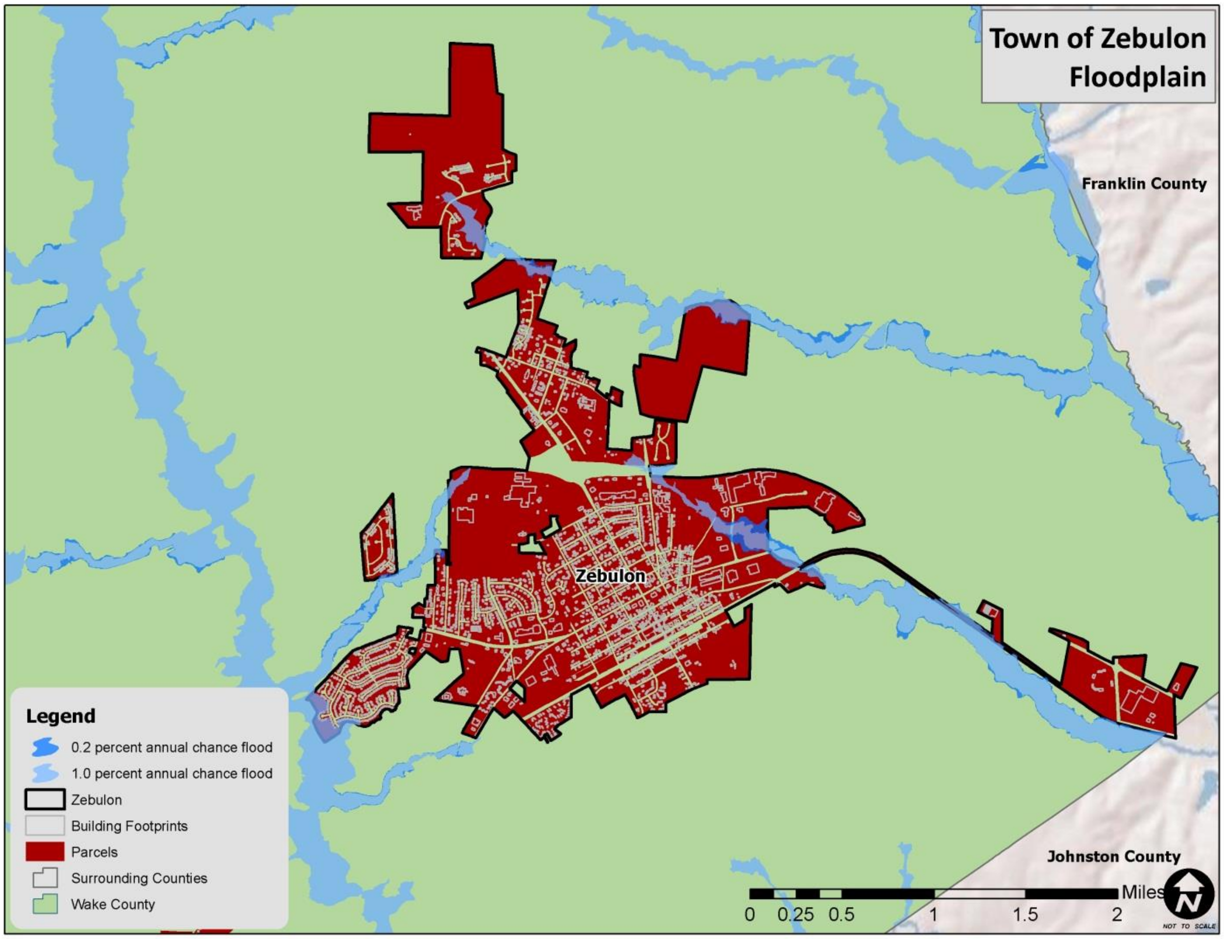
Location and Spatial Extent

There are areas in Zebulon that are susceptible to flood events. Special flood hazard areas in the jurisdiction were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[14] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, of the 4 square miles that make up Zebulon, there are 0.13 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain).

These flood zone values account for 3.3 percent of the total land area in Zebulon. It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas. **Figure L.7** illustrates the location and extent of currently mapped special flood hazard areas for Zebulon based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.

[14] The county-level DFIRM data used for Zebulon were updated in 2010.

FIGURE L.7: SPECIAL FLOOD HAZARD AREAS IN ZEBULON



Source: Federal Emergency Management Agency

Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported no events in Zebulon since 1993.[15] A summary of these events is presented in **Table L.23**. These events accounted for $0 (2013 dollars) in property damage in the jurisdiction.[16] Specific information on flood events, including date, type of flooding, and deaths and injuries, can be found in **Table L.24**.

TABLE L.23: SUMMARY OF FLOOD OCCURRENCES IN ZEBULON

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Zebulon	0	0/0	$0

Source: National Climatic Data Center

[15] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.

[16] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

TABLE L.24: HISTORICAL FLOOD EVENTS IN ZEBULON

	Date	Type	Deaths/ Injuries	Property Damage*
Zebulon				
None reported				

Source: National Climatic Data Center

Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there have been 7 flood losses reported in Zebulon through the National Flood Insurance Program (NFIP) since 1978. A summary of these figures for the jurisdiction is provided in **Table L.25**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that additional instances of flood loss in Zebulon were either uninsured, denied claims payment, or not reported.

TABLE L.25: SUMMARY OF INSURED FLOOD LOSSES IN ZEBULON

Location	Flood Losses	Claims Payments
Zebulon	7	$183,092

Source: FEMA, NFIP

Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

As of July 2013, there are 0 non-mitigated repetitive loss properties located in Zebulon, which accounted for 0 losses and $0 in claims payments under the NFIP. Without mitigation, repetitive loss properties will likely continue to experience flood losses. **Table L.26** presents detailed information on repetitive loss properties and NFIP claims and policies for Zebulon.

TABLE L.26: SUMMARY OF REPETITIVE LOSS PROPERTIES IN ZEBULON

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Zebulon	0	-	0	$0	$0	$0	$0

Source: National Flood Insurance Program

Probability of Future Occurrences

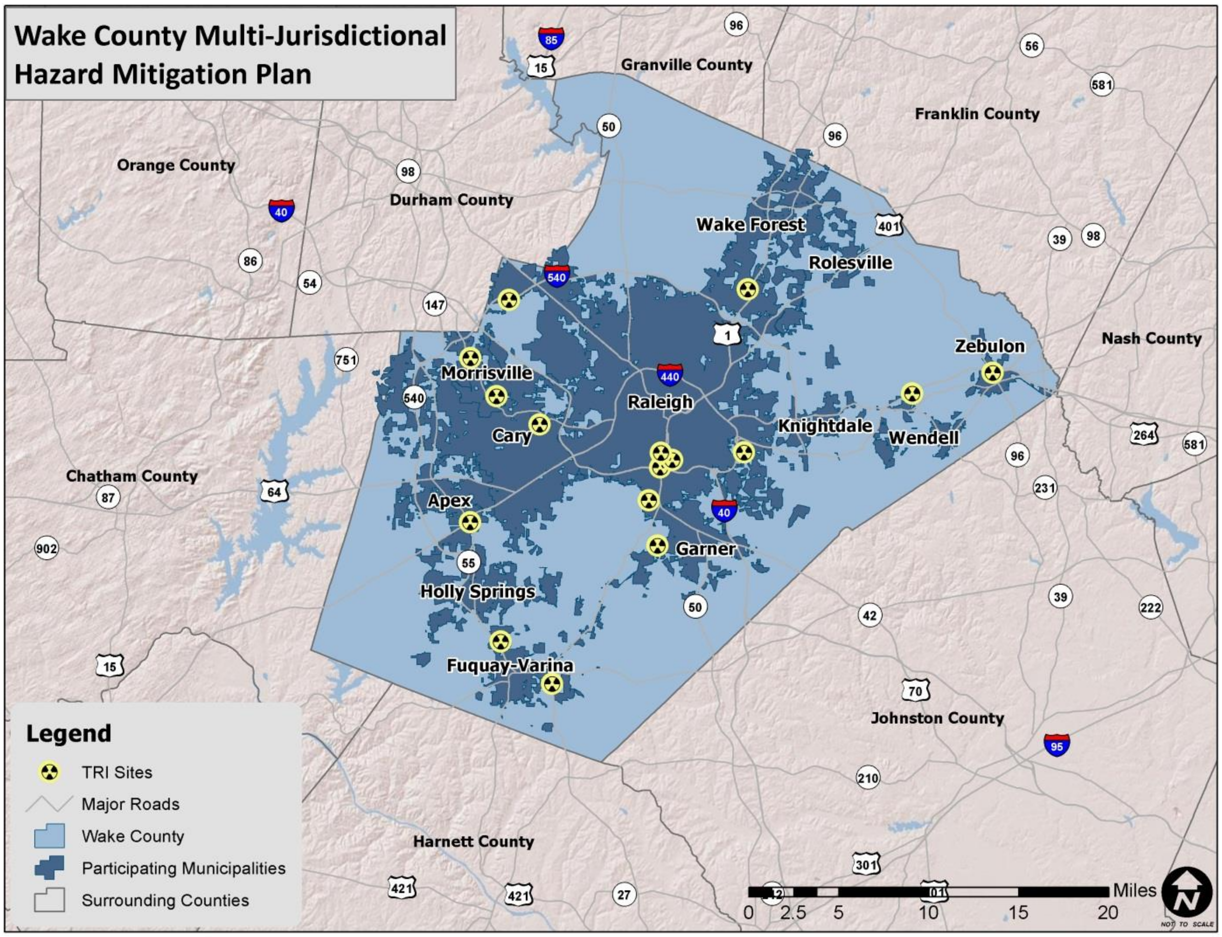
Flood events will remain a threat in areas prone to flooding in Zebulon, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability) The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above**,** which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

L.2.14 Hazardous Materials Incidents

Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Zebulon has one TRI site. This site is shown in **Figure L.8.**

FIGURE L.8: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the jurisdiction via roadways and rail. All roads that permit hazardous material transport are considered potentially at risk to an incident.

Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table L.27 presents detailed information on historic HAZMAT incidents reported in Zebulon.

TABLE L.27: SUMMARY OF HAZMAT INCIDENTS IN ZEBULON

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Zebulon							
I-2004090250	4/1/2004	ZEBULON	Highway	No	0/0	$0	0.125 LGA

Source: USDOT PHMSA

Probability of Future Occurrences

Given the location of one toxic release inventory site in Zebulon and several roadways and rails that transport hazardous materials, it is possible that a hazardous material incident may occur in the jurisdiction (between 1 percent and 10 percent annual probability). Local officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

L.2.15 Wildfire

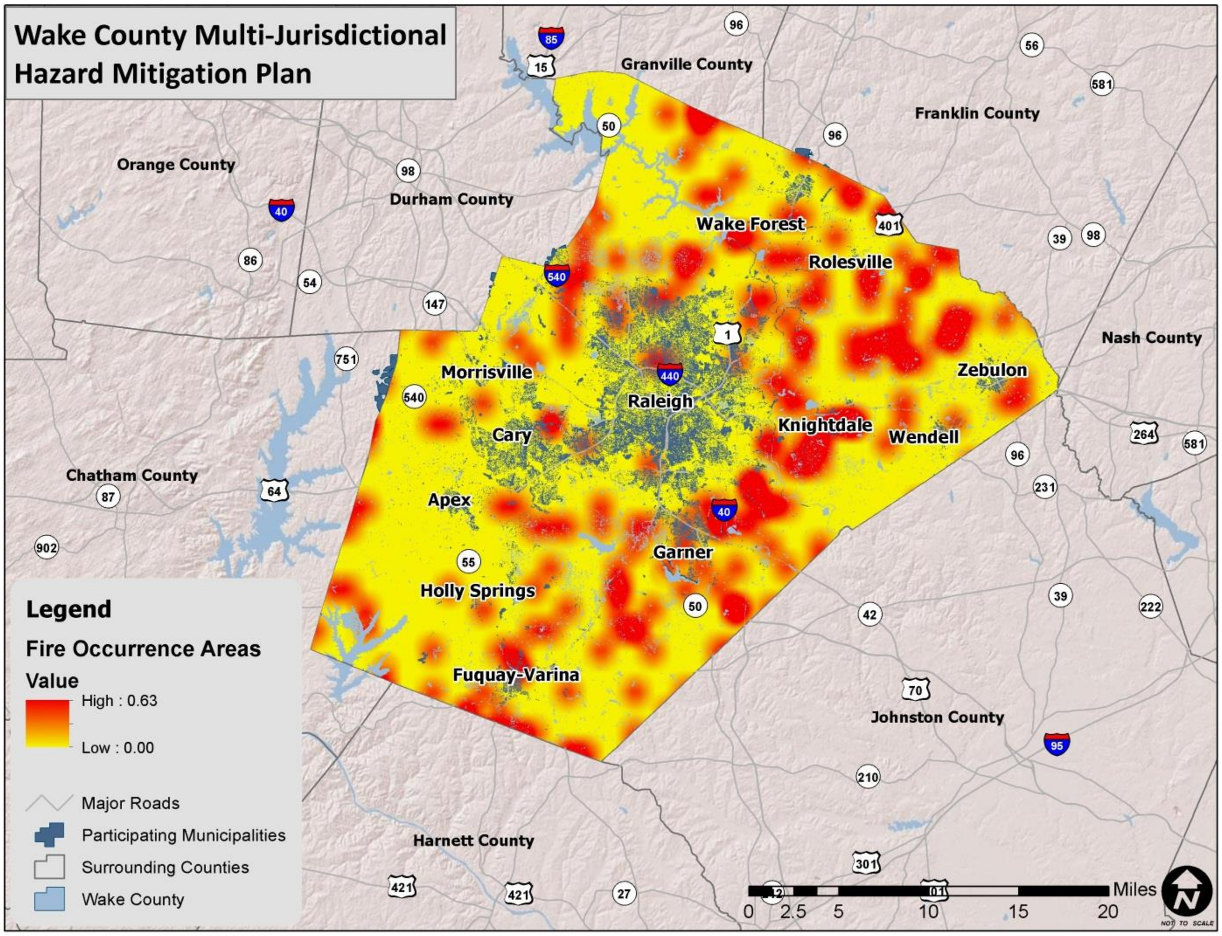
Location and Spatial Extent

The entire jurisdiction is at some risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas.

Historical Occurrences

Figure L.9 shows the Fire Occurrence Areas (FOA) in Zebulon based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. Therefore, even areas classified as at relatively high risk within the county are a relatively low risk compared to other areas of the state.

FIGURE L.9: HISTORIC WILDFIRE EVENTS IN ZEBULON



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of 16 wildfires annually which burn an average of 98 acres per year. The data indicates that most of these fires are small, averaging six acres per fire. **Table L.28** lists the number of reported wildfire occurrences in the county between the years 2003 and 2012.

TABLE L.28: HISTORICAL WILDFIRE OCCURRENCES IN ZEBULON

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Zebulon. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Zebulon for future wildfire events is possible (a 1 and 10 percent annual probability).

L.2.16 Nuclear Accident

Location and Spatial Extent

The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station.

Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 "Alerts" and 28 "Notice of Unusual Events" since 1986, which are shown in **Table L.29**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table L.29: SHEARON HARRIS EMERGENCY DECLARATION HISTORY

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on "B" Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).

Emergency Declaration	Date	Description
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of "A" Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - "B" diesel generator was being worked on; in accordance with test procedures, "A" diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported "Notice of Unusual Events" since 1986, which is shown in **Table L.30**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table L.30: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Probability of Future Occurrences

A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

L.2.17 Terror Threat

Location and Spatial Extent

A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table L.31** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

TABLE L.31 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food ▪ Banking and Finance ▪ Chemical ▪ Commercial Facilities ▪ Communications ▪ Critical Manufacturing ▪ Dams ▪ Defense Industrial Base ▪ Emergency Services ▪ Energy	▪ Government Facilities ▪ Healthcare and Public Health ▪ Information Technology ▪ National Monuments and Icons ▪ Nuclear Reactors, Materials, and Waste ▪ Postal and Shipping ▪ Transportation Systems ▪ Water

Historical Occurrences

Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

Probability of Future Occurrences

Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

L.2.18 Conclusions on Hazard Risk

The hazard profiles presented above were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and

experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

Hazard Extent

Table L.32 describes the extent of each natural hazard identified for Zebulon. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE L.32 EXTENT OF ZEBULON HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page L:4). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Zebulon has received this ranking three times over the fourteen year reporting period.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Zebulon was 1.75 inches. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), Zebulon is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Thunderstorm Wind/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Zebulon was reported at 50 knots (approximately 58 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). The greatest magnitude reported was an F0 (reported on September 18, 2012).
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Zebulon. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is low in Zebulon.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). The one dam in Zebulon is not classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records located in Zebulon.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 3.3 percent of the total land area in Zebulon. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second.
Other Hazards	
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incident reported in the region is 0.125 LGA released on the highway in Zebulon. It should be noted that larger events are possible.
Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).
Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

Priority Risk Index Results

In order to draw some meaningful planning conclusions on hazard risk for Zebulon, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). More information on the PRI and how it was calculated can be found in Section 5.20.2.

Table L.33 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups and Coordinating Committee. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE L.33: SUMMARY OF PRI RESULTS FOR ZEBULON

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	**2.5**
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	**2.4**
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	**2.5**
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	**2.1**
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	**3.1**
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.7**
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	**2.5**
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2**
Landslide	Unlikely	Minor	Small	Less than 6 hours	Less than 6 hours	**1.5**
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	**1.8**
Flood	Likely	Critical	Small	6 to 12 hours	Less than 1 week	**2.8**
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	**2**
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	**2.6**
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	**2.4**

L.2.16 Final Determinations on Hazard Risk

The conclusions drawn from the hazard profiling process for Zebulon, including the PRI results and input from the Regional Work Groups and Coordinating Committee, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table L.34**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Zebulon. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment* and below in Section L.3. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE L.34: CONCLUSIONS ON HAZARD RISK FOR ZEBULON

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Nuclear Accident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

L.3 TOWN OF ZEBULON VULNERABILITY ASSESSMENT

This subsection identifies and quantifies the vulnerability of Zebulon to the significant hazards previously identified. This includes identifying and characterizing an inventory of assets in the county and assessing the potential impact and expected amount of damages caused to these assets by each identified hazard event. More information on the methodology and data sources used to conduct this assessment can be found in Section 6: *Vulnerability Assessment*.

L.3.1 Asset Inventory

Table L.35 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for Zebulon (study area of vulnerability assessment).[17]

TABLE L.35: IMPROVED PROPERTY IN ZEBULON

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Zebulon	2,251	$476,102,834	2,145	$346,897,517

Table L.36 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in Zebulon. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities. In addition, a list of secondary facilities was created to recognize the importance of these facilities in the event of a disaster. These facilities were not mapped, but it is important to recognize that they could be potentially impacted by nearly any of the identified hazards, especially those that are atmospheric or have no specific spatial delineation.

All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure L.10** shows the locations of the primary critical facilities in Wake County. **Table L.48**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility. As noted previously, this list is not all-inclusive and only includes information provided by the local government.

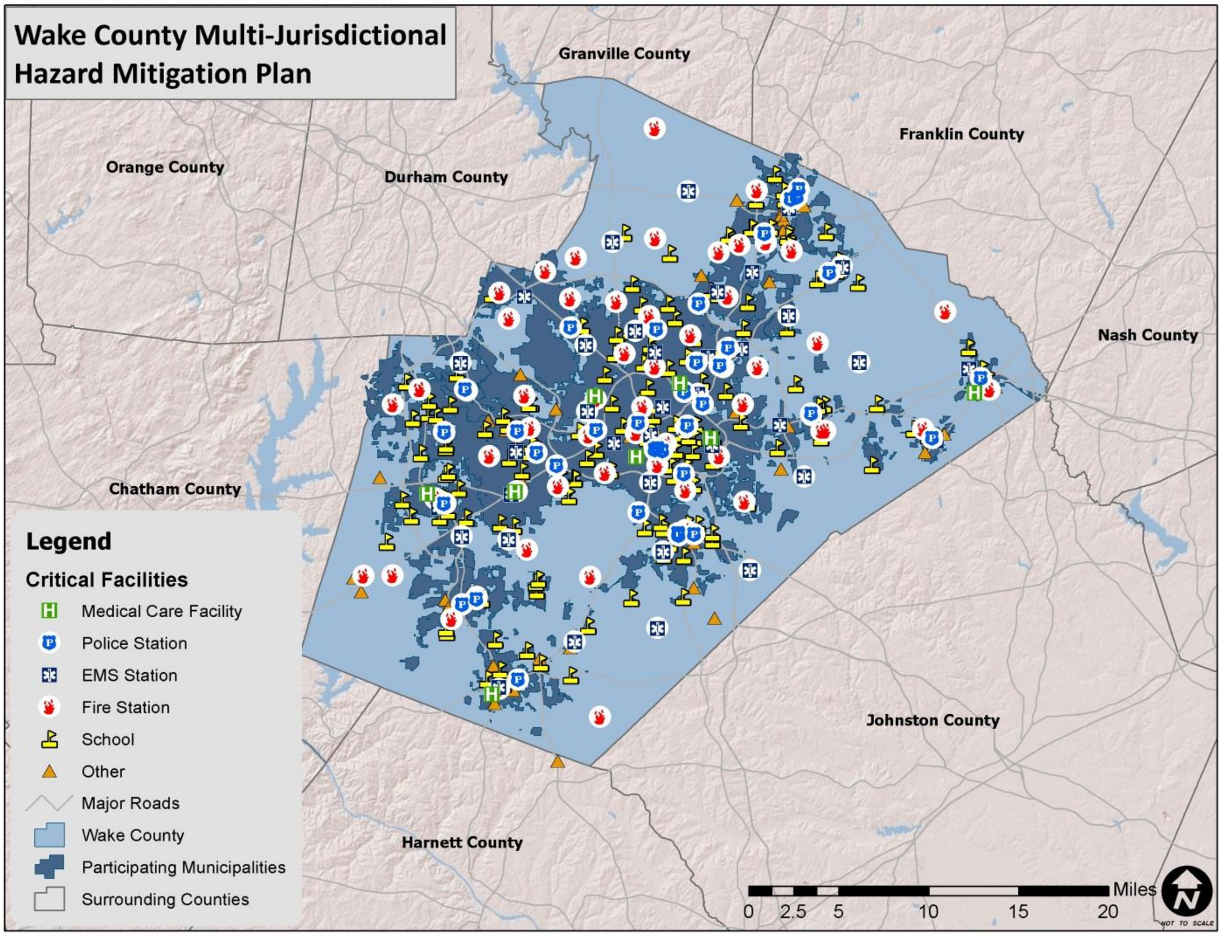
TABLE L.36: CRITICAL FACILITY INVENTORY IN ZEBULON

Location	Fire Stations	Police Stations	EMS Stations	Medical Care Facilities	Schools	Other
Zebulon	1	1	1	1	3	2

Source: Local Governments

[17] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

FIGURE L.10: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: Local Governments

L.3.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Zebulon that are potentially at risk to these hazards.

Table L.37 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, limited the results to county-wide estimates. The total population in Zebulon according to Census data is 4,433 persons. Additional population estimates are presented above in Section L.1.

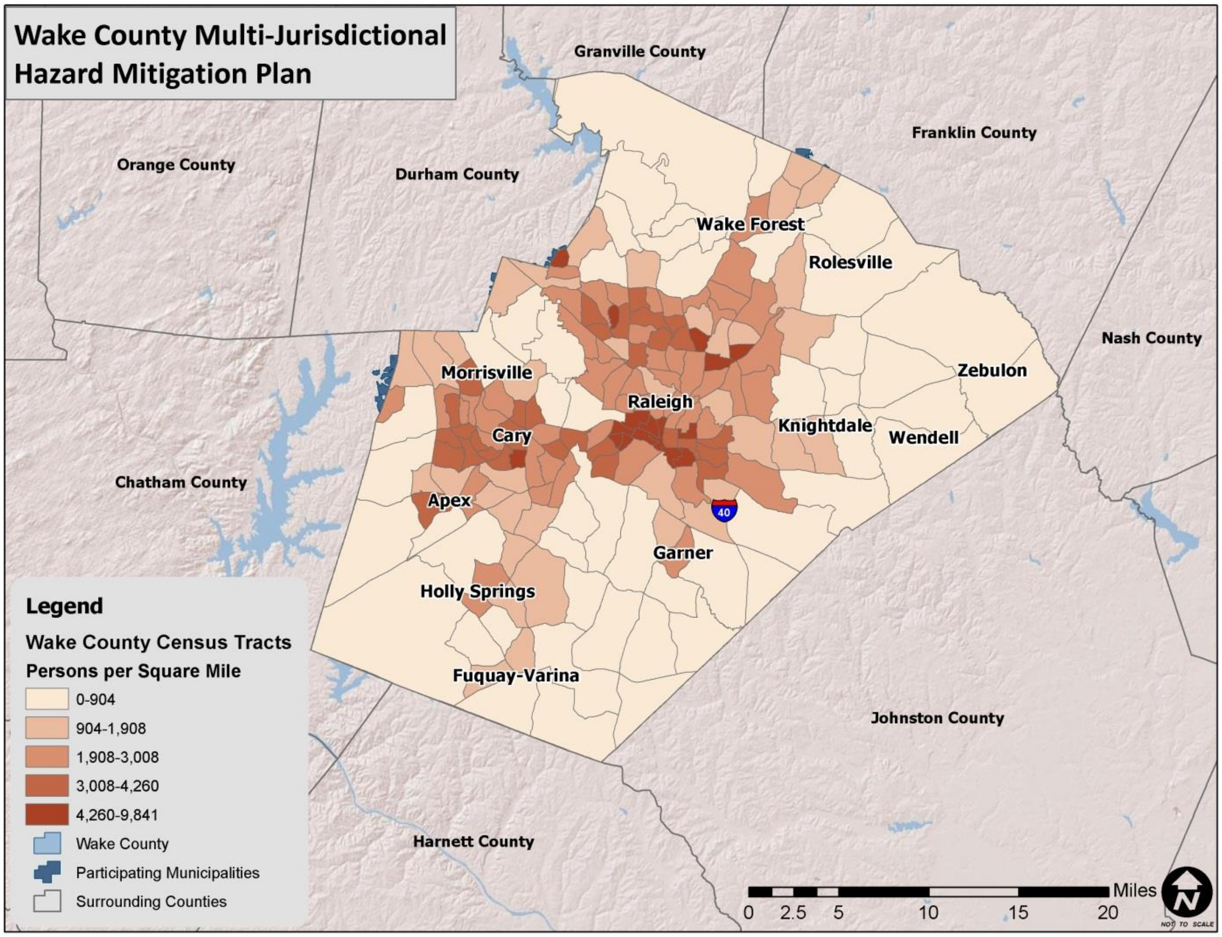
TABLE L.37: TOTAL POPULATION IN ZEBULON

Location	Total 2010 Population
Zebulon	4,433

Source: U.S. Census 2010

In addition, **Figure L.11** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[18]

FIGURE L.11: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

L.3.3 Vulnerability Assessment Results

As noted in Section 6: *Vulnerability Assessment*, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results, specific to Zebulon, are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total county exposure, and thus risk, was presented in **Table L.35**.

The annualized loss estimate for all hazards is presented at the end of this section in **Table L.47.**

The hazards presented in this section include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

[18] Population by census block was not available at the time this plan was completed.

Hurricane and Tropical Storm

Historical evidence indicates that Zebulon has a significant risk to the hurricane and tropical storm hazard. Several tracks have come near or traversed through the county, as shown and discussed in Section L.2.4.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes, and high winds and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table L.38.** Only losses to buildings are reported, in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE L.38: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table L.39.**

TABLE L.39: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Zebulon	76.3	85.7	103.0	108.9

Source: Hazus-MH 2.1

Social Vulnerability

Given equal susceptibility across the county, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Zebulon, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table L.48** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Zebulon. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

Earthquake

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table L.40** summarizes the findings.

TABLE L.40: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability

It can be assumed that all existing future populations are at risk to the earthquake hazard.

Critical Facilities

The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table L.48**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Zebulon. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

Landslide

In order to complete the vulnerability assessment for landslides in Zebulon, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section L.2.10), tax parcel and building footprint data, and GIS analysis. **Table L.41** presents the potential at-risk property where available. All areas of Zebulon are identified as low incidence areas by the USGS landslide data. Since there were no high incidence levels in the county, the moderate incidence level was used to identify different areas of concern for the analysis below.

TABLE L. 41: TOTAL POTENTIAL AT-RISK PARCELS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	**Moderate**		
Zebulon	0	0	$0

Source: USGS

Social Vulnerability
Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides.

Critical Facilities
No critical facilities are located in a moderate susceptibility area. A list of specific critical facilities and their associated risk can be found in **Table L.48** at the end of this section.

In conclusion, a landslide has the potential to impact existing and future buildings, facilities, and populations in Zebulon, though some areas are at a higher risk than others due to a variety of factors. For example, steep slopes and modified slopes bear a greater risk than flat areas. Specific vulnerabilities for county assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

Flood
Historical evidence indicates that Zebulon is susceptible to flood events. No flood events have been reported by the National Climatic Data Center resulting in $0 in damages. On an annualized level, these damages amounted to $0 for Zebulon.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for the county. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table L.42** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

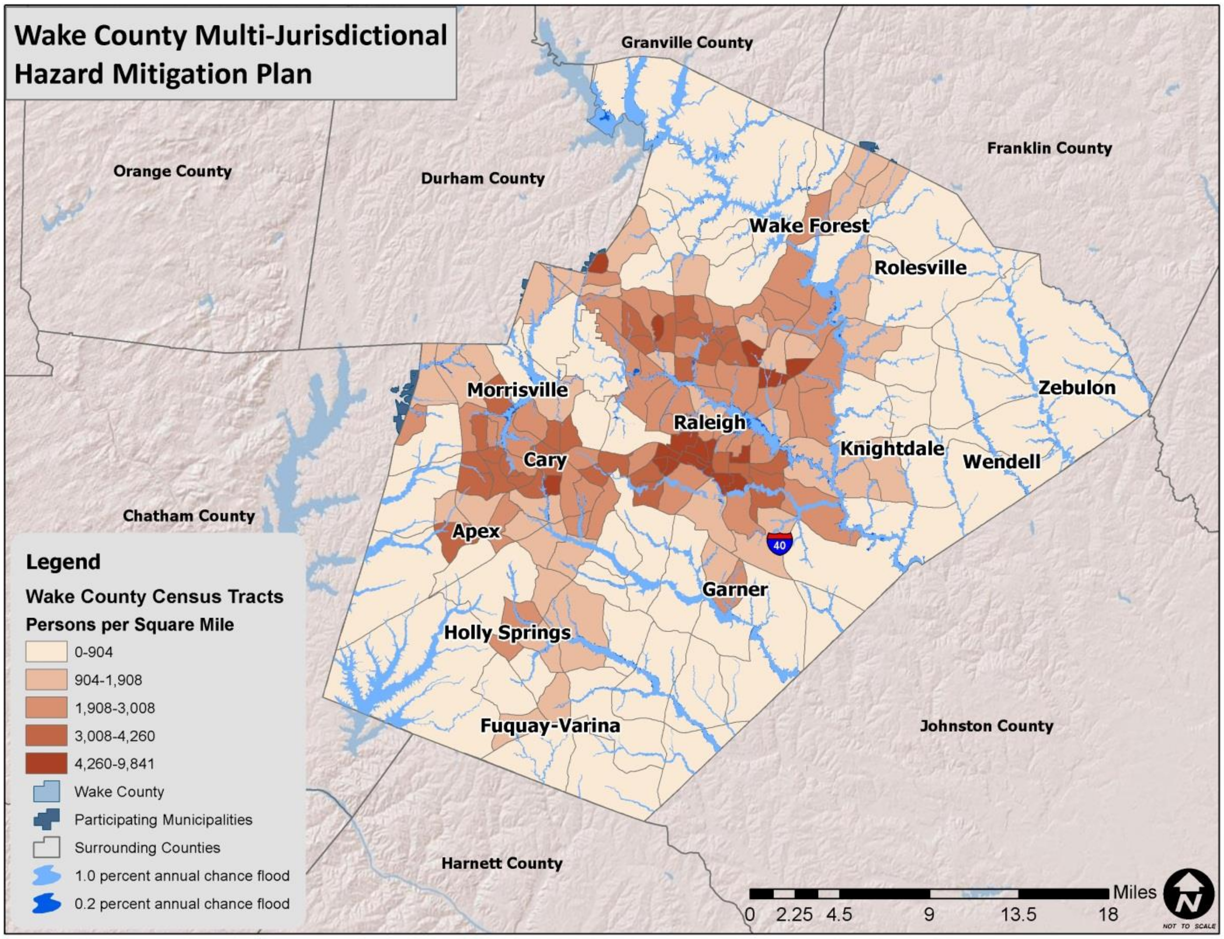
TABLE L.42: ESTIMATED EXPOSURE OF PARCELS TO THE FLOOD HAZARD

Location	1.0-percent ACF			0.2-percent ACF		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings
Zebulon	59	21	$38,958,547	6	0	$2,141,294

Source: FEMA DFIRM

Social Vulnerability
Since 2010 population was available at the tract level, it was difficult to determine a reliable figure on population at-risk to flood due to tract level population data. **Figure L.12** is presented to gain a better understanding of at risk population.

FIGURE L.12 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities
The critical facility analysis revealed that there are a no critical facilities located in the Zebulon 1.0-percent annual chance floodplain and 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. A list of specific critical facilities and their associated risk can be found in **Table L.48** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings and populations in Zebulon, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

Hazardous Materials Incident
Although historical evidence and existing Toxic Release Inventory sites indicate that Zebulon is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to

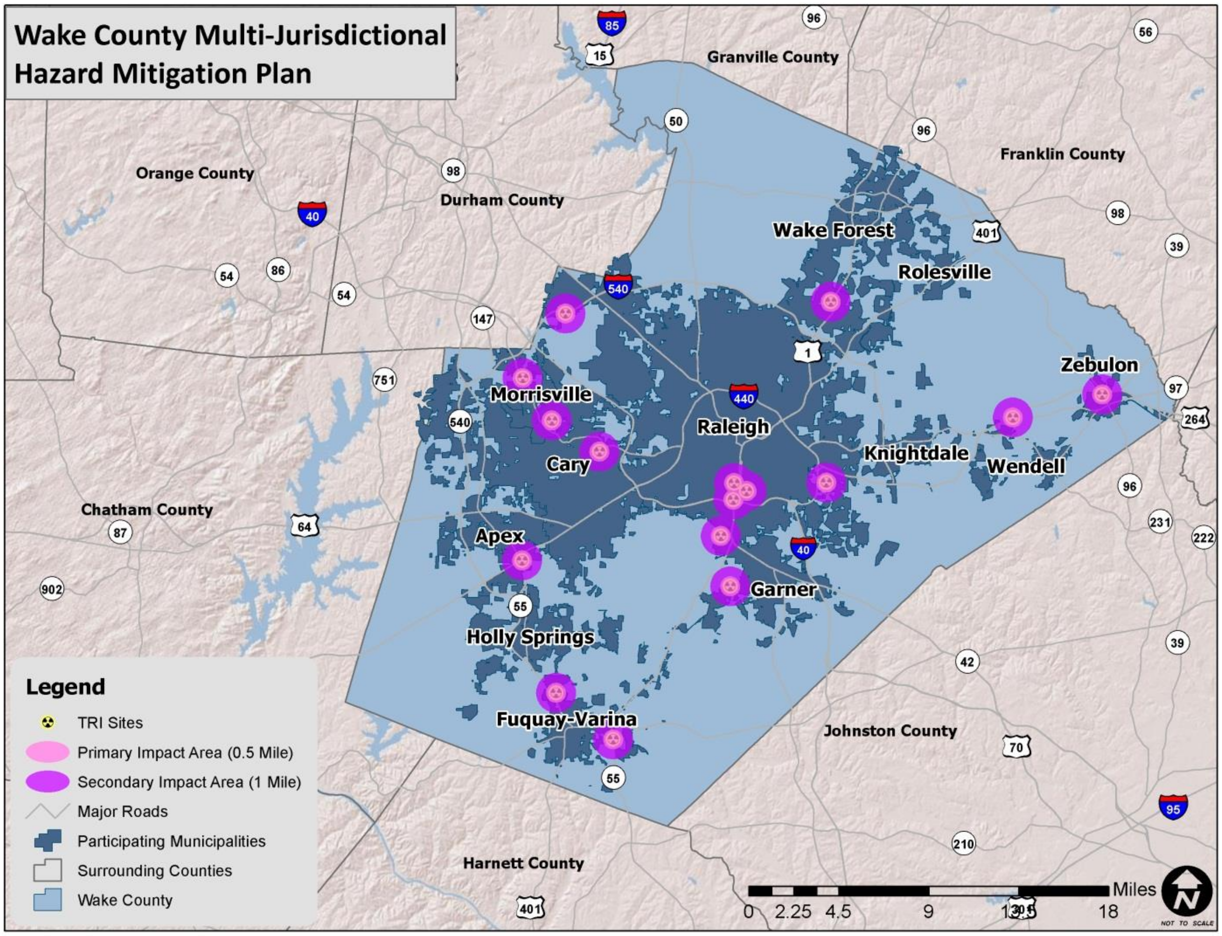
calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Zebulon.

Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[19] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Zebulon, along with buffers, were used for analysis as shown in **Figure L.13.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the GIS buffer analysis. **Figure L.14** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table L.43** (fixed sites), **Table L.44** (mobile road sites) and **Table L.45** (mobile railroad sites).[20]

[19] This type of analysis will likely yield inflated results (generally higher than what is actually reported after an event).
[20] Note that parcels included in the 1.0-mile analysis are also included in the 0.5-mile analysis.

FIGURE L.13 : TRI SITES WITH BUFFERS IN ZEBULON



Source: EPA

TABLE L.43: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Zebulon	409	432	$89,772,024	1,459	1,449	$244,329,129

FIGURE L.14 : MOBILE HAZMAT BUFFERS IN ZEBULON

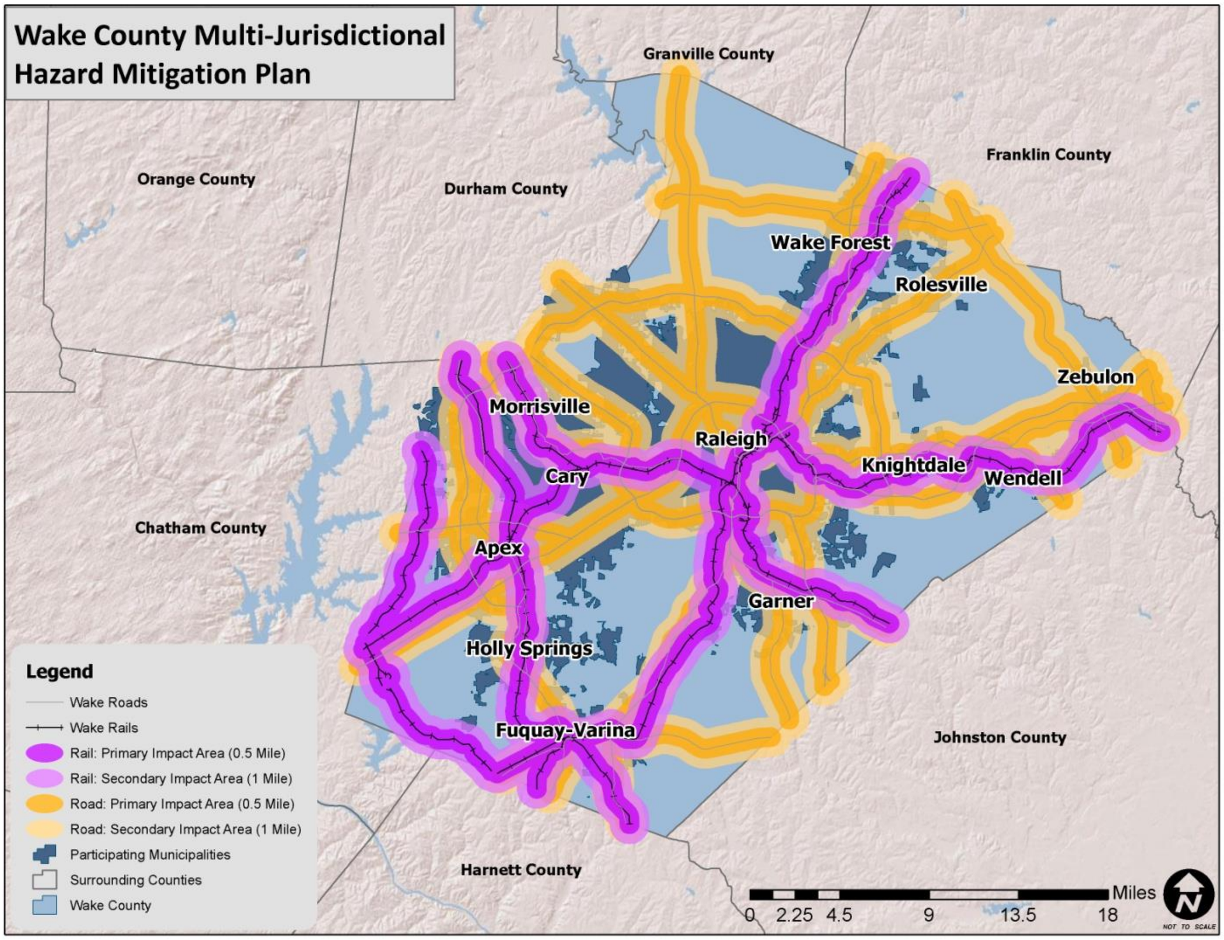


TABLE L.44: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Zebulon	2,172	2,114	$343,376,813	2,251	2,145	$346,897,517

TABLE L.45: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Zebulon	826	886	$152,232,553	1,680	1,805	$263,618,682

Social Vulnerability

Given high susceptibility across the jurisdiction, it is assumed that the total population is at risk to a hazardous materials incident. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities

Fixed Site Analysis:

The critical facility analysis for fixed TRI sites revealed that 7 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes just 4 facilities. The remaining facilities are in the secondary, 1.0-mile zone. A list of specific critical facilities and their associated risk can be found in **Table L.48** at the end of this section.

Mobile Analysis:

The critical facility analysis for road and railroad transportation corridors in Zebulon revealed that there are 8 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 8 facilities. The railroad buffer areas include 6 facilities with 3 in the primary impact zone. It should be noted that many of the facilities located in the buffer areas for railroad are also located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table L.48** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Zebulon. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc. Further, incidents from neighboring jurisdictions could also have an impact.

Wildfire

Although historical evidence indicates that Zebulon is susceptible to wildfire events, there are few reports of damage. Upon conversion of the wildfire risk data (see Section 6: *Vulnerability Assessment*) and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the jurisdiction should be assumed to be very low. As such, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the county.

Social Vulnerability

All areas have relatively equal vulnerability and there is low susceptibility across the entire county.
It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in wildfire areas of concern. It should be noted, however, that several factors could impact the spread of a wildfire putting all facilities at risk. A list of specific critical facilities and their associated risk can be found in **Table L.48** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Zebulon.

Nuclear Accident

The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table L.46** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE L.46: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[21]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[22]
Zebulon	0	0	$0	2,251	2,145	$346,897,517

Social Vulnerability

Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities

The critical facility analysis revealed that there are no critical facilities located in the 10-mile nuclear buffer area in Zebulon.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in Zebulon, though areas closer to the power plant are at a higher risk than others. All structures are at some risk given that they are all located within at least the 50-mile buffer area.

Conclusions on Hazard Vulnerability

Table L.47 presents a summary of annualized loss for each hazard in Zebulon. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, although an annualized loss was determined through the damage reported through historical occurrences at the municipal level, it is likely that the county-wide

[21] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.

[22] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

estimate (found in Section 6: *Vulnerability Assessment*) is potentially a better estimate. These values should be used as an additional planning tool or measure risk for determining hazard mitigation strategies.

TABLE L.47: ANNUALIZED LOSS FOR ZEBULON*

Event	Zebulon
Dam Failure	Negligible
Drought	Negligible
Erosion	Negligible
Extreme Heat	Negligible
Hail	Negligible
Hurricane & Tropical Storm	Negligible
Landslide	Negligible
Lightning	Negligible
Thunderstorm Wind/High Wind[23]	$2,518
Tornado	Negligible
Winter Storm & Freeze	Negligible
Flood	Negligible
Earthquake	Negligible
HAZMAT Incident	Negligible
Wildfire	Negligible
Nuclear Accident	Negligible
Terror Threat	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table L.48** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

[23] The annualized losses for these hazards were combined.

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TABLE L.48: AT-RISK CRITICAL FACILITIES IN ZEBULON

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
ZEBULON																								
ZEBULON FIRE STATION AND EMS STATION	FIRE STATION	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
EASTERN WAKE- WAKEMED	MEDICAL CARE FACILITY	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
TOWN HALL	OTHER	X	X	X	X	X	X	X	X	X					X	X	X	X		X			X	X
PUBLIC WORKS	OTHER	X	X	X	X	X	X	X	X	X						X	X	X	X	X			X	X
ZEBULON	POLICE STATION	X	X	X	X	X	X	X	X	X					X	X	X	X		X			X	X
ZEBULON MS	SCHOOL	X	X	X	X	X	X	X	X	X					X	X	X	X		X			X	X
ZEBULON ES	SCHOOL	X	X	X	X	X	X	X	X	X					X	X	X	X					X	X
WAKELON ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X

Secondary Critical Facilities are listed in slight contrast to Critical Facilities as their continued function has not been deemed as critical as primary facilities in the event of a disaster, but these facilities are extremely important. A loss of function to one of these facilities would have a definitively greater negative impact on the community's ability to respond to and recover from a disaster than a loss of function at other facilities/structures within the jurisdiction. In **Table L.49**, these facilities have been classified as either Significant Community Locations/Sheltering Centers or as Critical Resources Management Facilities. These facilities are all vulnerable to any of the atmospheric hazards and many are also likely vulnerable to other hazards identified above, though no locational analysis was carried out to this end.

TABLE L.49: ZEBULON SECONDARY CRITICAL FACILITIES

Facility Name	Address*	Type
Zebulon		
Community Center	301 S. Arendell Ave	Significant Community Location or Sheltering Center
Bell South Phone Service		Critical Resources Management (Energy, Water, etc.)
Duke Progress Energy		Critical Resources Management (Energy, Water, etc.)
Public Service of North Carolina		Critical Resources Management (Energy, Water, etc.)
Water, Sewer, Reuse by City of Raleigh		Critical Resources Management (Energy, Water, etc.)
Wake County Public Library- Zebulon		Significant Community Location or Sheltering Center
Mudcat Baseball Stadium		Significant Community Location or Sheltering Center
Wake County Eastern Regional Center		Significant Community Location or Sheltering Center
Coventry House		Significant Community Location or Sheltering Center
Zebulon Charter School		Significant Community Location or Sheltering Center
Yarborough-O'Neal Villa		Significant Community Location or Sheltering Center
Zebulon Post		Significant Community Location or Sheltering Center

**Some address information could not be provided or was not applicable to the facility*

L.4 TOWN OF ZEBULON CAPABILITY ASSESSMENT

This subsection discusses the capability of the Town of Zebulon to implement hazard mitigation activities. More information on the purpose and methodology used to conduct the assessment can be found in Section 7: *Capability Assessment*.

L.4.1 Planning and Regulatory Capability

Table L.50 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the Town of Zebulon. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE L.50: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning Tool/Regulatory Tool	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan (Parks & Rec/Greenway Plan	Stormwater Management Plan/Ordinance	Natural Resource Protection Plan	Flood Response Plan	Emergency Operations Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	National Flood Insurance Program (NFIP)	NFIP Community Rating System
Zebulon	✓	✓		✓	✓			✓			*	✓			✓	✓	✓	*		✓	✓	✓	

A more detailed discussion on the town's planning and regulatory capabilities follows.

Emergency Management

Hazard Mitigation Plan
The Town of Zebulon has previously adopted a hazard mitigation plan.

Emergency Operations Plan
The Town of Zebulon has adopted the Wake County Emergency Operations Plan.

General Planning

Comprehensive Land Use Plan
The Town of Zebulon has adopted a comprehensive development plan.

Capital Improvements Plan
The Town of Zebulon has a six-year capital improvement plan in place.

Zoning Ordinance
The Town of Zebulon has adopted a zoning ordinance and is in the process of developing a local unified development ordinance.

Subdivision Ordinance
The Town of Zeulon has adopted a subdivision ordinance and is in the process of developing a local unified development ordinance.

Building Codes, Permitting, and Inspections
North Carolina has a state compulsory building code which applies throughout the state. Wake County provides building inspections for the Town of Zebulon.

Floodplain Management

Table L.51 provides NFIP policy and claim information for the Town of Zebulon.

TABLE L.51: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
Zebulon	07/03/78	04/16/13	18	$3,176,000	7	$183,092

Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Flood Damage Prevention Ordinance
All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. The Town of Zebulon participates in the NFIP and has adopted flood damage prevention regulations.

Open Space Management Plan
The Town of Zebulon has adopted the *Zebulon and Wendell Open Space and Greenway Plan*.

Stormwater Management Plan
The Town of Zebulon has adopted a stormwater management plan.

L.4.2 Administrative and Technical Capability

Table L.52 provides a summary of the capability assessment results for the Town of Zebulon with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in the town with the specified knowledge or skill.

TABLE L.52: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	Planners with knowledge of land development/land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency Manager	Floodplain Manager	Land Surveyors	Scientists familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Resource development staff or grant writers
Zebulon	✓	✓	✓	✓	✓		✓	✓	✓	

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

L.4.3 Fiscal Capability

Table L.53 provides a summary of the results for the Town of Zebulon with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plan.

TABLE L.53: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes (or taxing districts)	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.
Zebulon	✓	✓	✓			✓			✓	✓

L.4.4 Political Capability

The previous hazard mitigation plan indicates that officials, staff, and residents of the Town of Zebulon are very supportive of mitigation efforts. They foresee significant development in the future and understand the important that the town be developed in a manner that reduces the possibility of impacts from natural disasters. This attitude toward mitigation measures is expected to continue in the future, even as mayors and commissioners change.

L.4.5 Conclusions on Local Capability

Table L.54 shows the results of the capability assessment using the designed scoring methodology described in Section 7: *Capability Assessment*. The capability score is based solely on the information found in existing hazard mitigation plan and readily available on the town's government website. According to the assessment, the local capability score for the town is 38, which falls into the moderate capability ranking.

TABLE L.54: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
Zebulon	40	High

L.5 TOWN OF ZEBULON MITIGATION STRATEGY

This subsection provides the blueprint for Zebulon to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Regional Work Groups and the findings and conclusions of the capability assessment and risk assessment. Additional Information can be found in Section 8: *Mitigation Strategy* and Section 9: *Mitigation Action Plan*.

L.5.1 Mitigation Goals

Zebulon developed seven mitigation goals in coordination with Wake County and the other participating municipalities. The county-wide mitigation goals are presented in **Table L.55**.

TABLE L.55: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

L.5.2 Mitigation Action Plan

The mitigation actions proposed by Zebulon are listed in the following Mitigation Action Plan.

Town of Zebulon Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Prepare Hazard Mitigation Plan Update.	All	High	Zebulon Advisory Committee	Town of Zebulon	2014, Every 5 years	The Hazard Mitigation Plan will be completed by Fall 2014. This action will be removed in the next update.
P-2	Adopt Hazard Mitigation Plan Update.	All	High	Zebulon Board of Commissioners	Town of Zebulon	Upon approval of HMP by FEMA	The Hazard Mitigation Plan will be completed by Fall 2014. This action will be removed in the next update.
P-3	Prepare Plan maintenance report.	All	High	Zebulon Planning Department	Town of Zebulon	2015, Annually	Plan maintenance meetings have been held annually and will continue to be held going forward.
P-4	Prepare Updates of Hazard Mitigation Plan.	All	High	Zebulon Planning Department	Town of Zebulon	As needed	Multi-jurisdictional plan update occurring currently. This action will be removed in the next update.
P-5	Revise Hazard Mitigation Plan.	All	High	Zebulon Advisory Committee	Town of Zebulon	Every 5 years	Multi-jurisdictional plan update occurring currently. This action will be removed in the next update.
P-6	Keep evacuation routes open.	All	High	Zebulon Public Works, Public Safety	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
P-7	Maintain trees adjacent to power lines and critical facilities.	All	High	Zebulon Public Works, Progress Energy	Town of Zebulon, Progress Energy	Completed	Integrated into staff duties. This action will be removed in the next update.
P-8	Maintain water supply system.	All	High	Zebulon Public Works	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
P-9	Maintain sewer lift stations, including generators.	All	High	Zebulon Public Works	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
P-10	Install generators as needed at life stations.	All	High	Zebulon Public Works	Town of Zebulon	Deleted	Remove – done by City of Raleigh so this should be removed.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-11	Maintain storm drainage system.	Flooding	High	Zebulon Public Works	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
P-12	Implement disaster notification policy.	All	High	Zebulon Public Safety	Town of Zebulon	Completed	In place. This action will be removed in the next update.
P-13	Implement Community Center Use Policy.	All	High	Zebulon Parks & Recreation	Town of Zebulon	Deleted	Does not meet State and Federal qualifications
P-14	Update inclement weather policy.	All	High	All Town Departments	Town of Zebulon	Completed	Personnel Policy Update has been implemented.
P-15	Enforce subdivision standards for development in flood hazard areas.	Flood	High	Zebulon Planning & Inspections	Town of Zebulon, Wake County	2015	Development of and inclusion within UDO to take place in the future.
P-16	Further restrict development in floodplain by prohibiting development or requiring 2 feet of freeboard.	Flood	High	Zebulon Planning	Town of Zebulon	2015	Development of and inclusion within UDO to take place in the future.
P-17	Revise floodplain ordinance.	Flood	High	Zebulon Planning	Town of Zebulon	2015	Development of and inclusion within UDO to take place in the future.
P-18	Require burial of power lines for new developments.	Hurricane, Tornadoes, Winter Storms/ Freezes	Moderate	Zebulon Planning	Town of Zebulon	2015	Development of and inclusion within UDO to take place in the future.
P-19	Require new construction to comply with wind section of Building Code.	Hurricane, Tornadoes, Severe Thunderstorms	High	Zebulon Inspections	Wake County	Completed	Integrated into staff duties. This action will be removed in the next update.
P-20	Implement snow, ash, and debris removal policies.	Hurricane Tornadoes, Winter Storms/ Freezes, Wildfires	High	Zebulon Administration, Public Works	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
P-21	Prepare and implement debris removal and disposal plan.	Hurricane Tornadoes, Winter Storms/ Freezes, Wildfires	Moderate	Zebulon Administration, Public Works	Town of Zebulon	2014	Upon approval by FEMA and Board of Commissioners
P-22	Require new construction to comply with snow load requirements of Building Code.	Winter Storms/ Freezes	High	Zebulon Inspections	Wake County	Completed	Integrated into staff duties. This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-23	Include flood map data on GIS system.	Flood	Moderate	Zebulon Planning	Town of Zebulon	Six Months after receipt of revised FIRM maps	These will be included in GIS systems Six Months after receipt of revised FIRM maps
P-24	Tie law enforcement to Statewide 800 megahertz system.	All	Moderate	Zebulon Public Safety	Town of Zebulon	2018	Although some work has been done to integrate this system, this is anticipated to be fully integrated by 2018
Natural Resource Protection							
NRP-1	Maintain and expand greenway system, stream buffers.	Flood	Low	Zebulon Park & Recreation	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
Public Education and Awareness							
PEA-1	Provide links to hazard notices on Town website.	All	Moderate	Zebulon Town Web Administrator	Town of Zebulon	This will occur directly prior to or during a hazard event	The town has been able to update the town website with hazard notices prior to events and will continue to do so going forward.
PEA-2	Inform public of construction requirements in hazard areas.	Flood	Moderate	Zebulon Building Inspectors	Wake County	Completed	Integrated into staff duties. This action will be removed in the next update.
PEA-3	Require disclosure of flood hazard in real estate transactions.	Flood	Moderate	Zebulon Planning Department	Town of Zebulon	2015	Development of and inclusion within UDO to take place in the future.
PEA-4	Public outreach projects.	All	Moderate	Zebulon Administration	Town of Zebulon	2018	The town will work to develop public outreach projects that help citizens become better prepared to deal with disasters.
PEA-5	Make FEMA manuals available to residents.	All	Moderate	Zebulon Planning Department	Town of Zebulon	Completed	Integrated into staff duties. This action will be removed in the next update.
PEA-6	Present Plan at public meeting.	All	Moderate	Zebulon Planning	Town of Zebulon	Upon approval of HMP by FEMA	Upon approval of HMP by FEMA This action will be removed in the next update.
PEA-7	Post Plan maintenance report for public comment.	All	Moderate	Zebulon Town Manager	Town of Zebulon	Upon approval of HMP by FEMA	Upon approval of HMP by FEMA This action will be removed in the next update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-8	Post copy of approval Plan in Town Hall.	All	Moderate	Zebulon Planning	Town of Zebulon	Upon approval of HMP by FEMA	Upon approval of HMP by FEMA This action will be removed in the next update.
PEA-9	Provide links to flood warnings, hurricane tracking information, tornado and severe thunderstorm warnings, winter storm warnings, wildfire warnings, and any other available hazard warning information on website.	All	Low	Zebulon Town Web Administrator	Town of Zebulon	2018	The town will work on reaching out to the public utilizing different communication channels and will review and update its outreach program
PEA-10	Make flood maps available to public.	Flood	Moderate	Zebulon Planning	Town of Zebulon	Completed	Integrated into staff duties This action will be removed in the next update.
PEA-11	Keep website updates with latest storm and emergency response information.	All	Low	Zebulon Town Web Administrator	Town of Zebulon	Completed	The town has been able to update the town website with hazard notices prior to events and will continue to do so going forward.

Annex M
Wake County

This annex includes jurisdiction-specific information for Wake County. It consists of the following five subsections:

- M.1 Wake County Community Profile
- M.2 Wake County Risk Assessment
- M.3 Wake County Vulnerability Assessment
- M.4 Wake County Capability Assessment
- M.5 Wake County Mitigation Strategy

M.1 WAKE COUNTY COMMUNITY PROFILE

M.1.1 Geography and the Environment

Wake County is best known as being home of the capital of North Carolina, Raleigh, and is home to a number of government agencies and functions. Many state agencies are located in Wake County as are many federal agencies.

Wake County is also known as one of three counties that comprise the Research Triangle metropolitan region, so named for the Research Triangle Park (RTP) which encompasses the three major metropolitan areas of Chapel-Hill, Durham, and Raleigh. Each of these metropolitan areas is home to a major research university (UNC-Chapel Hill, Duke, and NC State University, respectively) and RTP draws on these universities for its workforce. The Research Triangle Park is a hub of high-tech and biotech research and is a defining feature of the economy in Wake County.

Summer temperatures generally venture into the 90s for highs and cool off to the 70s at night. Winter temperatures in can drop to below freezing but generally highs are in the 50s. Rainfall is most common in the summer months but occurs consistently throughout the year.

M.1.2 Population and Demographics

According to the 2010 Census, Wake County has a population of 900,993 people. The county has seen exceptional growth between 2000 and 2010, and the population density is almost 1,100 people per square mile. Population counts from the US Census Bureau for 1990, 2000, and 2010 are presented in **Table M.1**.

TABLE M.1: POPULATION COUNTS FOR WAKE COUNTY

Jurisdiction	1990 Census Population	2000 Census Population	2010 Census Population	% Change 2000-2010
WAKE COUNTY	**423,380**	**627,846**	**900,993**	**43.51%**

Source: US Census Bureau

The racial characteristics of the county are presented in **Table M.2**. Whites make up the majority of the population in the county, accounting for over 65 percent of the population.

TABLE M.2: DEMOGRAPHICS OF WAKE COUNTY

Jurisdiction	White Persons, Percent (2010)	Black Persons, Percent (2010)	American Indian or Alaska Native, Percent (2010)	Other Race, Percent (2010)	Persons of Hispanic Origin, Percent (2010)*
WAKE COUNTY	**66.3%**	**20.7%**	**0.5%**	**12.5%**	**9.1%**

*Hispanics may be of any race, so also are included in applicable race categories
Source: US Census Bureau

M.1.3 Housing

According to the 2010 US Census, there are 371,836 housing units in Wake County, the majority of which are single family homes or mobile homes. Housing information for the county is presented in **Table M.3**.

TABLE M.3: HOUSING CHARACTERISTICS

Jurisdiction	Housing Units (2000)	Housing Units (2010)	Seasonal Units, Percent (2010)	Median Home Value (2007-2011)
WAKE COUNTY	**258,953**	**371,836**	**7.0%**	**$230,400**

Source: US Census Bureau

M.1.4 Infrastructure

Transportation

There are several major roadways that cross Wake County. The most prominent is Interstate 40 which runs through the county on an east-west track. It has two spurs that more or less encompass the city of Raleigh and provide access to many of the outlying municipalities. In conjunction with I-40, I-440 makes up the "Beltline" that encircles most of central Raleigh. Meanwhile, I-540/NC-540 is a partly completed loop that is outside the beltline that currently connects many of the northern and western municipalities. In addition to the Interstate, there are many major highways that traverse the county. Federal highways of note are US-1, US-64, US-264, US-70, and US-401, while state highways in the county include NC-39, NC-42, NC-50, NC-54, NC-55, NC-96, NC-98, and NC-231.

In terms of other transportation services, Raleigh-Durham International Airport (RDU) is one of the largest airports in the state and serves more than 35 international and domestic locations and over 9 million passengers a year. Wake County is also home to two Amtrak railway facilities, located in Raleigh and Cary. The Triangle Transit authority operates a bus system that connects Raleigh, Durham, and Chapel-Hill and there are also several intra-county bus lines that provide service between Wake County municipalities.

Utilities

Electrical power in Wake County is provided by two entities and Duke Energy and Wake Electric Membership Corporation with Duke Energy providing service to a majority of the county. Water and sewer service is provided by two main entities as well: The City of Raleigh Public Utilities and Western Wake Partners. Natural gas is provided by PSNC Energy.

Community Facilities

There are a number of public buildings and community facilities located throughout Wake County. According to the data collected for the vulnerability assessment (Section 6.4.1), there are 81 fire stations, 38 police stations, and 158 public schools located within the study area.

Three major hospitals are located in Wake County: Rex Hospital, WakeMed, and Duke Raleigh. WakeMed also operates several satellite locations throughout the county.

Wake County is also home to several parks, including three state parks: Falls Lake State Recreation Area, William B. Umstead State Park, and Jordan Lake State Recreation Area. There are also a number of county and municipal parks located throughout the jurisdictions, including the American Tobacco Trail which is a rails to trails project that is open to a wide variety of non-motorized uses.

M.1.5 Land Use

Much of Wake County is developed and relatively urbanized. However, there are some areas that are more sparsely developed, sometimes due to the conservation of land. As shown in **Figure 3.1** above, there are many incorporated municipalities located throughout the study area, and these areas are where the region's population is generally concentrated. The incorporated areas are also where many businesses, commercial uses, and institutional uses are located. Land uses in the balance of the study area consist of a variety of types of residential, commercial, industrial, government, and recreational uses. Local land use and associated regulations are further discussed in *Section 7: Capability Assessment.*

M.1.6 Employment and Industry

According to the North Carolina Employment Security Commission, in 2012 (the last full year with data available), Wake County had an average annual employment of 453,415 workers. The Retail Trade industry employed 11.4% of the County's workforce followed by Health Care and Social Assistance (10.5%); Professional and Technical Services (9.3%); and Accommodation and Food Services (9.2%). In 2012, the projected median household income was $60,412 compared to $42,941 for the state of North Carolina in 2011 (2012 numbers were not available).

M.2 WAKE COUNTY RISK ASSESSMENT

This subsection includes hazard profiles for each of the significant hazards identified in Section 4: *Hazard Identification* as they pertain to Wake County. Where possible data has been included only for the unincorporated area of Wake County. Each hazard profile includes a description of the hazard's location and extent, notable historical occurrences, and the probability of future occurrences. Additional information can be found in Section 5: *Hazard Profiles*.

M.2.1 Drought

Location and Spatial Extent

Drought typically covers a large area and cannot be confined to any geographic or political boundaries. According to the Palmer Drought Severity Index, Wake County has a relatively low risk for drought hazard. However, local areas may experience much more severe and/or frequent drought events than what is represented on the Palmer Drought Severity Index map. Furthermore, it is assumed that the county would be uniformly exposed to drought, making the spatial extent potentially widespread. It is also notable that drought conditions typically do not cause significant damage to the built environment.

Historical Occurrences

According to the North Carolina Drought Monitor, Wake County has had drought occurrences all of the last fourteen years (2000-2013). **Table M.4** shows the most severe drought classification for each year, according to North Carolina Drought Monitor classifications.

TABLE M.4: HISTORICAL DROUGHT OCCURRENCES IN WAKE COUNTY

Abnormally Dry **Moderate Drought** **Severe Drought** **Extreme Drought** **Exceptional Drought**

	Wake County
2000	MODERATE
2001	SEVERE
2002	**EXCEPTIONAL**
2003	ABNORMAL
2004	ABNORMAL
2005	SEVERE
2006	SEVERE
2007	**EXCEPTIONAL**
2008	**EXCEPTIONAL**
2009	MODERATE
2010	SEVERE
2011	SEVERE
2012	MODERATE
2013	MODERATE

Source: North Carolina Drought Monitor

Probability of Future Occurrences

Based on historical occurrence information, it is assumed that Wake County has a probability level of likely (10-100 percent annual probability) for future drought events. This hazard may vary slightly by location but each area has an equal probability of experiencing a drought. However, historical information also indicates that there is a much lower probability for extreme, long-lasting drought conditions.

M.2.2 Extreme Heat

Location and Spatial Extent

Excessive heat typically impacts a large area and cannot be confined to any geographic or political boundaries. All of Wake County is susceptible to extreme heat conditions.

Historical Occurrences

Data from the National Climatic Data Center was used to determine historical extreme heat and heat wave events in Wake County. There were two events reported:

July 22, 1998 – *Excessive Heat* - Excessive heat plagued central North Carolina during July 22 through July 23. Maximum temperatures reached the 98 to 103 degree range combined with dew points in the 78 to 80 degree range with little wind to give heat index values of around 110 degrees.

August 22, 2007 – *Heat* - An athlete from Enloe High School running track collapsed from heat exhaustion and was sent to the hospital in critical condition. The student remained in the hospital in critical condition for several days.

In addition, information from the State Climate Office of North Carolina was reviewed to obtain historical temperature records in the region. Temperature information has been reported since 1898. The recorded maximum for Wake County was 107 degrees Fahrenheit in Raleigh at North Carolina State University in 2011.

The State Climate Office also reports average maximum temperatures in various locations in the county. The most centralized location is in Raleigh at North Carolina State University. **Table M.5** shows the average maximum temperatures from 1971 to 2000 at the North Carolina State University observation station which can be used as a general comparison for the region.

Table M.5: AVERAGE MAXIMUM TEMPERATURE IN RALEIGH, WAKE COUNTY

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Avg. Max (°F)	48.8	53.0	61.2	70.6	77.5	84.4	87.9	85.9	80.0	69.8	61.3	52.1

Source: State Climate Office of North Carolina

Probability of Future Occurrences
Based on historical occurrence information, it is assumed that all of Wake County has a probability level of likely (10 to 100 percent annual probability) for future extreme heat events to impact the region.

M.2.3 Hailstorm

Location and Spatial Extent
Hailstorms frequently accompany thunderstorms, so their locations and spatial extents coincide. It is assumed that Wake County is uniformly exposed to severe thunderstorms; therefore, all areas are equally exposed to hail which may be produced by such storms.

Historical Occurrences
According to the National Climatic Data Center, 102 recorded hailstorm events have affected unincorporated Wake County since 1993.[1] **Table M.6** is a summary of the hail events in unincorporated Wake County. **Table M.7** provides detailed information about each event that occurred. In all, hail occurrences resulted in $0 (2013 dollars) in property damages. Hail ranged in diameter from 0.75 inches to 3.00 inches. It should be noted that hail is notorious for causing substantial damage to cars, roofs, and other areas of the built environment that may not be reported to the National Climatic Data Center. Therefore, it is likely that damages are greater than the reported value.

[1] These hail events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional hail events have affected Wake County. In addition to NCDC, the North Carolina Department of Insurance office was contacted for information. As additional local data becomes available, this hazard profile will be amended.

TABLE M.6: SUMMARY OF HAIL OCCURRENCES IN WAKE COUNTY

Location	Number of Occurrences	Property Damage (2013)
Unincorporated Wake County	102	$0

Source: National Climatic Data Center

TABLE M.7: HISTORICAL HAIL OCCURRENCES IN WAKE COUNTY

	Date	Magnitude	Deaths/Injuries	Property Damage*
Wake County				
Wake County	8/15/1958	1 in.	0/0	$0
Wake County	3/19/1966	1 in.	0/0	$0
Wake County	3/19/1966	1 in.	0/0	$0
Wake County	2/9/1970	0.75 in.	0/0	$0
Wake County	5/23/1973	0.75 in.	0/0	$0
Wake County	5/28/1973	1.75 in.	0/0	$0
Wake County	4/8/1976	1.5 in.	0/0	$0
Wake County	4/19/1978	1.25 in.	0/0	$0
Wake County	4/19/1978	1 in.	0/0	$0
Wake County	6/22/1978	1 in.	0/0	$0
Wake County	4/27/1980	1.75 in.	0/0	$0
Wake County	4/27/1980	0.75 in.	0/0	$0
Wake County	4/27/1980	0.75 in.	0/0	$0
Wake County	4/30/1981	0.75 in.	0/0	$0
Wake County	6/3/1982	1 in.	0/0	$0
Wake County	6/3/1982	1.75 in.	0/0	$0
Wake County	6/3/1982	2 in.	0/0	$0
Wake County	6/16/1982	2 in.	0/0	$0
Wake County	5/26/1983	0.75 in.	0/0	$0
Wake County	4/16/1985	0.75 in.	0/0	$0
Wake County	6/24/1986	1.75 in.	0/0	$0
Wake County	6/24/1986	1.75 in.	0/0	$0
Wake County	8/2/1986	0.75 in.	0/0	$0
Wake County	7/13/1987	1.5 in.	0/0	$0
Wake County	8/21/1987	1.75 in.	0/0	$0
Wake County	10/6/1987	1 in.	0/0	$0
Wake County	5/17/1988	1.75 in.	0/0	$0
Wake County	5/19/1988	1 in.	0/0	$0
Wake County	5/19/1988	1 in.	0/0	$0
Wake County	6/2/1988	2 in.	0/0	$0
Wake County	6/2/1988	0.75 in.	0/0	$0
Wake County	6/17/1988	1 in.	0/0	$0
Wake County	7/19/1988	0.75 in.	0/0	$0
Wake County	7/31/1988	1 in.	0/0	$0
Wake County	9/24/1988	2.5 in.	0/0	$0
Wake County	4/25/1989	1.75 in.	0/0	$0
Wake County	6/15/1989	0.88 in.	0/0	$0
Wake County	6/16/1989	3 in.	0/0	$0

	Date	Magnitude	Deaths/Injuries	Property Damage*
Wake County	4/2/1990	1 in.	0/0	$0
Wake County	5/4/1990	1.5 in.	0/0	$0
Wake County	6/3/1990	1 in.	0/0	$0
Wake County	7/1/1990	2.5 in.	0/0	$0
Wake County	8/29/1990	1.75 in.	0/0	$0
Wake County	8/29/1990	0.75 in.	0/0	$0
Wake County	6/26/1992	0.75 in.	0/0	$0
Wake County	6/26/1992	1 in.	0/0	$0
Wake County	7/26/1992	1 in.	0/0	$0
Wake County	9/4/1992	1.5 in.	0/0	$0
New Hill	3/27/1993	0.75 in.	0/0	$0
New Hill	5/19/1993	1.75 in.	0/0	$0
Wake County	5/1/1994	0.75 in.	0/0	$0
Wake County	5/26/1995	1.75 in.	0/0	$0
FALLS LAKE	5/11/1996	0.75 in.	0/0	$0
CARPENTER	3/21/1999	1 in.	0/0	$0
SHOTWELL	8/13/2000	0.88 in.	0/0	$0
NEW HILL	5/14/2006	0.75 in.	0/0	$0
FALLS	5/20/2006	0.75 in.	0/0	$0
BAYLEAF	5/9/2008	0.75 in.	0/0	$0
WAKE XRDS	5/9/2008	0.75 in.	0/0	$0
WILLOW SPGS	5/9/2008	0.88 in.	0/0	$0
NEWHILL	5/20/2008	1.75 in.	0/0	$0
WILLOW	5/20/2008	0.88 in.	0/0	$0
MACEDONIA	5/20/2008	0.75 in.	0/0	$0
WILLOW SPGS	5/20/2008	1 in.	0/0	$0
MACEDONIA	7/6/2008	0.75 in.	0/0	$0
MILLBROOK	7/22/2008	0.75 in.	0/0	$0
FAWLERS XRDS	5/5/2009	0.88 in.	0/0	$0
WILLOW SPGS	7/1/2009	0.75 in.	0/0	$0
FALLS	7/27/2009	1 in.	0/0	$0
LEESVILLE	7/28/2009	0.88 in.	0/0	$0
WILLIAMS XRDS	8/5/2009	0.88 in.	0/0	$0
ROYAL MILLS	2/28/2011	1 in.	0/0	$0
SIX FORKS	8/29/2011	1.25 in.	0/0	$0
ECHO HGTS	3/31/2012	0.75 in.	0/0	$0
AUBURN	3/31/2012	1.25 in.	0/0	$0
PET XRDS	5/4/2012	1 in.	0/0	$0
AUBURN	5/17/2012	1.25 in.	0/0	$0
AUBURN	5/23/2012	1.25 in.	0/0	$0
FORESTVILLE	5/23/2012	1 in.	0/0	$0
STARMOUNT	5/23/2012	1 in.	0/0	$0
STARMOUNT	5/23/2012	1 in.	0/0	$0
STARMOUNT	5/23/2012	1 in.	0/0	$0
BAYLEAF	7/1/2012	1 in.	0/0	$0
BAYLEAF	7/1/2012	1.75 in.	0/0	$0
UPCHURCH	7/1/2012	1 in.	0/0	$0

	Date	Magnitude	Deaths/Injuries	Property Damage*
FAWLERS XRDS	7/1/2012	1 in.	0/0	$0
FAWLERS XRDS	7/1/2012	1.5 in.	0/0	$0
BAYLEAF	7/1/2012	1.75 in.	0/0	$0
FALLS	7/1/2012	1 in.	0/0	$0
UPCHURCH	7/1/2012	1.75 in.	0/0	$0
SIX FORKS	7/1/2012	1 in.	0/0	$0
AUBURN	7/1/2012	1 in.	0/0	$0
FALLS	7/6/2012	1 in.	0/0	$0
STARMOUNT	7/6/2012	1.75 in.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences
Based on historical occurrence information, it is assumed that the probability of future hail occurrences is likely (10 – 100 percent annual probability). Since hail is an atmospheric hazard (coinciding with thunderstorms), it is assumed that Wake County has equal exposure to this hazard. It can be expected that future hail events will continue to cause minor damage to property and vehicles throughout the county.

M.2.4 Hurricane and Tropical Storm

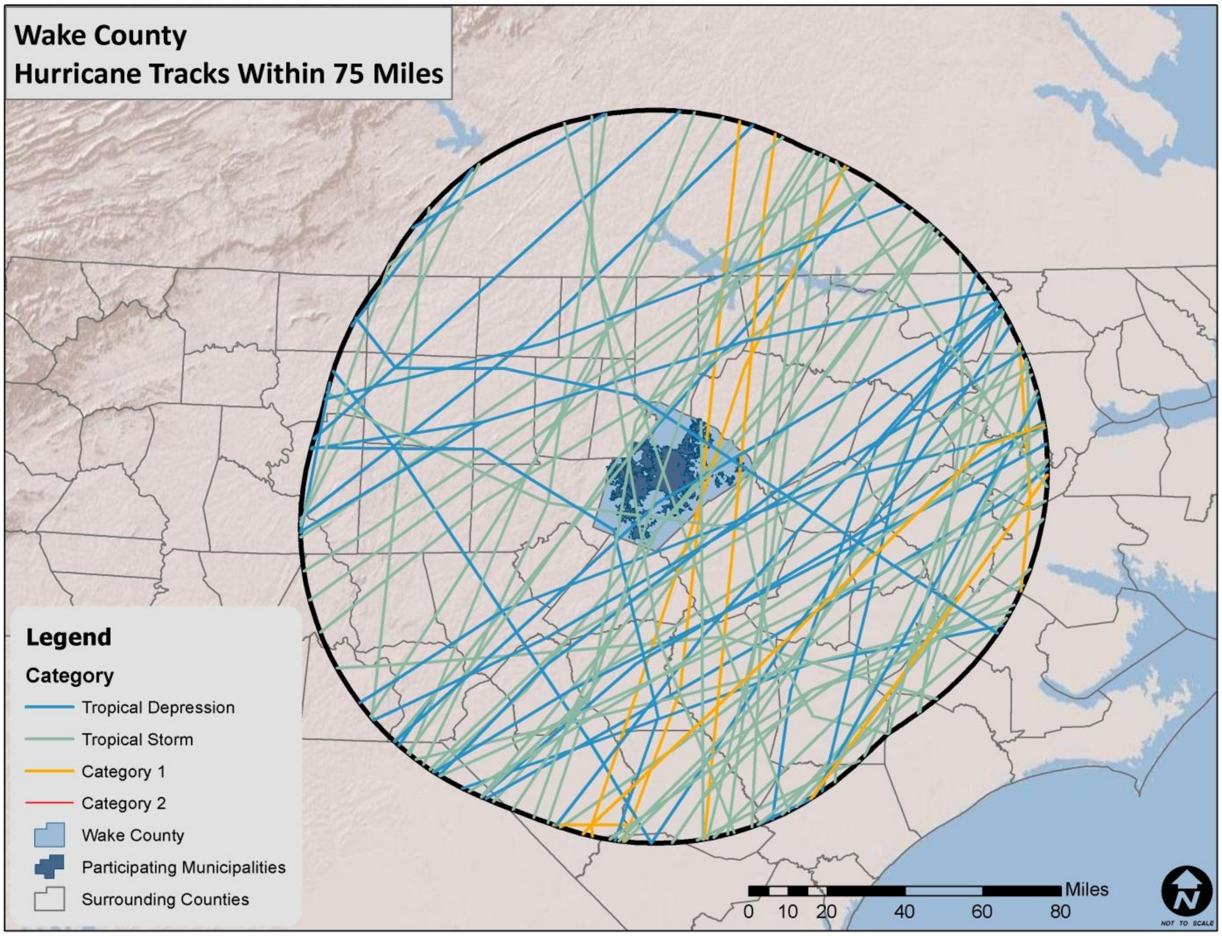
Location and Spatial Extent
Hurricanes and tropical storms threaten the entire Atlantic and Gulf seaboard of the United States. While coastal areas are most directly exposed to the brunt of landfalling storms, their impact is often felt hundreds of miles inland and they can affect Wake County. The entire jurisdiction is equally susceptible to hurricane and tropical storms.

Historical Occurrences
According to the National Hurricane Center's historical storm track records, 87 hurricane or tropical storm tracks have passed within 75 miles of Wake County since 1850.[2] This includes eight hurricanes, fifty-five tropical storms, and twenty-four tropical depressions.

Of the recorded storm events, twenty-one storms have traversed directly through Wake County as shown in **Figure M.1**. **Table M.8** provides for each event the date of occurrence, name (if applicable), maximum wind speed (as recorded within 75 miles of Wake County) and Category of the storm based on the Saffir-Simpson Scale.

[2] These storm track statistics do not include extra-tropical storms. Though these related hazard events are less severe in intensity, they may cause significant local impact in terms of rainfall and high winds.

FIGURE M.1: HISTORICAL HURRICANE STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY



Source: National Oceanic and Atmospheric Administration; National Hurricane Center

TABLE M.8: HISTORICAL STORM TRACKS WITHIN 75 MILES OF WAKE COUNTY (1850–2013)

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1851	NOT NAMED	35	Tropical Storm
1853	NOT NAMED	62	Tropical Storm
1854	NOT NAMED	57	Tropical Storm
1859	NOT NAMED	53	Tropical Storm
1859	NOT NAMED	35	Tropical Storm
1867	NOT NAMED	35	Tropical Storm
1873	XXXX873144	44	Tropical Storm
1873	NOT NAMED	44	Tropical Storm
1876	NOT NAMED	62	Tropical Storm
1877	NOT NAMED	48	Tropical Storm
1878	NOT NAMED	44	Tropical Storm
1878	NOT NAMED	79	Category 1
1882	NOT NAMED	53	Tropical Storm

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1883	NOT NAMED	44	Tropical Storm
1885	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	31	Tropical Depression
1886	NOT NAMED	35	Tropical Storm
1886	NOT NAMED	53	Tropical Storm
1887	NOT NAMED	31	Tropical Depression
1888	NOT NAMED	31	Tropical Depression
1889	NOT NAMED	35	Tropical Storm
1891	NOT NAMED	35	Tropical Storm
1893	NOT NAMED	44	Tropical Storm
1893	NOT NAMED	70	Category 1
1893	NOT NAMED	31	Tropical Depression
1896	NOT NAMED	62	Tropical Storm
1899	NOT NAMED	66	Category 1
1902	NOT NAMED	35	Tropical Storm
1902	NOT NAMED	31	Tropical Depression
1904	NOT NAMED	48	Tropical Storm
1907	NOT NAMED	53	Tropical Storm
1911	NOT NAMED	22	Tropical Depression
1912	NOT NAMED	53	Tropical Storm
1913	NOT NAMED	57	Tropical Storm
1913	NOT NAMED	66	Category 1
1915	NOT NAMED	35	Tropical Storm
1916	NOT NAMED	31	Tropical Depression
1916	NOT NAMED	31	Tropical Depression
1920	NOT NAMED	31	Tropical Depression
1924	NOT NAMED	53	Tropical Storm
1927	NOT NAMED	44	Tropical Storm
1928	NOT NAMED	35	Tropical Storm
1928	NOT NAMED	40	Tropical Storm
1929	NOT NAMED	35	Tropical Storm
1935	NOT NAMED	53	Tropical Storm
1940	NOT NAMED	62	Tropical Storm
1944	NOT NAMED	48	Tropical Storm
1944	NOT NAMED	31	Tropical Depression
1945	NOT NAMED	35	Tropical Storm
1946	NOT NAMED	22	Tropical Depression
1947	NOT NAMED	22	Tropical Depression
1954	HAZEL	70	Category 1
1955	DIANE	53	Tropical Storm
1956	IVY	35	Tropical Storm
1959	CINDY	26	Tropical Depression

Date of Occurrence	Storm Name	Maximum Wind Speed (miles per hour)	Storm Category
1960	BRENDA	44	Tropical Storm
1961	UNNAMED	44	Tropical Storm
1964	CLEO	26	Tropical Depression
1965	UNNAMED	26	Tropical Depression
1968	CELESTE	31	Tropical Depression
1970	ALMA	22	Tropical Depression
1971	UNNAMED	40	Tropical Storm
1971	HEIDI	40	Tropical Storm
1972	AGNES	35	Tropical Storm
1976	SUBTROP:SUBTROP 3	35	Tropical Storm
1979	DAVID	35	Tropical Storm
1984	DIANA	40	Tropical Storm
1985	ONE-C	31	Tropical Depression
1985	BOB	26	Tropical Depression
1987	UNNAMED	53	Tropical Storm
1996	JOSEPHINE	44	Tropical Storm
1996	BERTHA	57	Tropical Storm
1996	FRAN	57	Tropical Storm
1997	DANNY	31	Tropical Depression
1998	EARL	66	Category 1
1999	DENNIS	31	Tropical Depression
1999	FLOYD*	66	Category 1
2000	GORDON	35	Tropical Storm
2000	HELENE	35	Tropical Storm
2003	NOT NAMED	57	Tropical Storm
2004	CHARLEY	79	Category 1
2004	GASTON	35	Tropical Storm
2004	JEANNE	31	Tropical Depression
2006	ALBERTO	35	Tropical Storm
2008	OMAR	26	Tropical Depression
2008	SIXTEEN	26	Tropical Depression
2008	HANNA	40	Tropical Storm

Source: National Hurricane Center

The National Climatic Data Center reported seven events associated with a hurricane or tropical storm in Wake County between 1950 and 2013. These storms are listed in **Table M.9** and are generally representative of storms with the greatest impact on the county over the time period.

TABLE M.9: HISTORICAL HURRICANE/TROPICAL STORM OCCURRENCES IN WAKE COUNTY

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
7/12/1996	Hurricane Bertha	0/0	$0
9/5/1996	Hurricane Fran	7/2	$0
8/27/1998	Hurricane Bonnie	0/0	$0

Date of Occurrence	Storm Name	Deaths/Injuries	Property Damage*
9/4/1999	Hurricane Dennis	0/0	$0
9/15/1999	Hurricane Floyd	0/0	$179,765,471
9/18/2003	Hurricane Isabel	1/0	$776,235
9/1/2006	Tropical Storm Ernesto	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.

Federal records also indicate that three disaster declarations were made in 1996 (Hurricane Fran), 1999 (Hurricane Floyd), and 2003 (Hurricane Isabel) for the county.[3]

Flooding and high winds are both hazards of concern with hurricane and tropical storm events in Wake County as evidenced by the difference in impacts caused by Hurricanes Fran and Floyd. Whereas Floyd's effects were primarily due to flooding, Fran's high winds caused damage throughout the county in conjunction with flooding impacts. Some anecdotal information is available for the major storms that have impacted the area as found below:

Hurricane Fran – September 5-6, 1996
After being saturated with rain just a few weeks earlier by Hurricane Bertha, Wake County was impacted by the one of the most devastating storms to ever make landfall along the Atlantic Coast. Fran dropped more than 10 inches of rain in many areas and had sustained winds of around 115 miles per hour as it hit the coast and began its path along the I-40 corridor towards Wake County. In the end, over 900 million dollars in damages to residential and commercial property and at least 1 death were reported in Wake County alone. Damages to infrastructure and agriculture added to the overall toll and more than 1.7 million people in the state were left without power.

Hurricane Floyd – September 16-17, 1999
Much like Hurricane Fran, Hurricane Floyd hit the North Carolina coast just 10 days after Tropical Storm Dennis dropped more than 10 inches of rain in many areas of the state. As a result, the ground was heavily saturated when Floyd dumped an additional 15 to 20 inches in some areas. Although much of the heavy damage from the storm was found further east, Wake County suffered significant damage from the storm. Across the state more than 6 billion dollars in property damage was recorded and agricultural impacts were extremely high.

Probability of Future Occurrences
Given the inland location of the jurisdiction, it is less likely to be affected by a hurricane or tropical storm system than counties closer to the coast. However, given its location in the eastern part of the state, hurricanes and tropical storms still remain a real threat to Wake County. Based on historical evidence, the probability level of future occurrence is likely (annual probability between 10 and 100 percent). Given the regional nature of the hazard, all areas are equally exposed to this hazard. When the jurisdiction is impacted, the damage could be catastrophic, threatening lives and property throughout the planning area.

[3] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Identification*.

M.2.5 Lightning

Location and Spatial Extent

Lightning occurs randomly, therefore it is impossible to predict where and with what frequency it will strike. It is assumed that all of Wake County is uniformly exposed to lightning.

Historical Occurrences

According to the National Climatic Data Center, there have been twelve recorded lightning events in unincorporated Wake County since 1950, as listed in summary **Table M.10** and detailed in **Table M.11**.[4] However, it is certain that more lightning events have in fact impacted the jurisdiction. Many of the reported events are those that caused damage, and it should be expected that damages are likely much higher for this hazard than what is reported.

TABLE M.10: SUMMARY OF LIGHTNING OCCURRENCES IN WAKE COUNTY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Unincorporated Wake County	12	1/0	$294,407

Source: National Climatic Data Center

TABLE M.11: HISTORICAL LIGHTNING OCCURRENCES IN WAKE COUNTY

	Date	Deaths/Injuries	Property Damage*	Details
Wake County				
FALLS	7/24/1999	1/0	$0	A man was stepping from his boat onto the dock when he was hit by lightning. He never regained consciousness and died the next day.
MACEDONIA	7/16/2010	0/0	$11,255	A broken line of showers and thunderstorms developed across western North Carolina during the afternoon and then moved east across central and eastern North Carolina during the evening hours
FALLS	7/20/2010	0/0	$11,255	An upper level disturbance combined with strong afternoon heating to produce scattered strong to severe storms. Additional storms then developed along the numerous outflow boundaries.

[4] These lightning events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional lightning events have occurred in Wake County. The State Fire Marshall's office was also contacted for additional information but none could be provided. As additional local data becomes available, this hazard profile will be amended.

	Date	Deaths/Injuries	Property Damage*	Details
WILDERS GROVE	7/17/2010	0/0	$11,255	Thunderstorms developed across Virginia and central North Carolina as a small long lived MCS crossed the central and southern Appalachians. Widespread wind damage was reported across northern and central portions of central North Carolina.
SIX FORKS	7/29/2010	0/0	$2,251	A line of strong to severe storms formed as a cold front moved into a very moist and moderately unstable air mass..
LEESVILLE	7/20/2010	0/0	$16,883	An upper level disturbance combined with strong afternoon heating to produce scattered strong to severe storms. Additional storms then developed along the numerous outflow boundaries.
FORESTVILLE	7/1/2009	0/0	$5,796	A strong upper level disturbance and attendant surface cold front combined to produce scattered showers and thunderstorms across the eastern half of central North Carolina. The unseasonably dry low levels of the atmosphere across central North Carolina created a favorable environment for any thunderstorms that developed to produce damaging winds. Many of the thunderstorms that developed became severe and produced damaging winds across the eastern half of central North Carolina
UPCHURCH	6/15/2010	0/0	$56,275	A broken line of thunderstorms, some which were severe, tracked east across the Northwest and Eastern Piedmont. The storms were associated with a weak upper level

	Date	Deaths/Injuries	Property Damage*	Details
				disturbance which combined with afternoon heating.
UPCHURCH	6/22/2010	0/0	$140,689	Strong insolation underneath an oppressive upper level heat ridge resulted in isolated pulse severe convection.
WILLOW	6/2/2010	0/0	$28,138	Strong to severe slow moving storms and merging storms resulted in severe damaging winds and flash flooding across portions of Central North Carolina. Frequent to excessive lightning resulted in property damage across the area to homes and businesses.
WYATT	5/9/2012	0/0	$5,305	A cold front moved into central North Carolina and interacted with an unstable air mass to produce scattered showers and thunderstorms. Some of these storms became strong to severe across portions of the Piedmont and Coastal Plain of central North Carolina.
UPCHURCH	7/6/2012	0/0	$5,305	An upper level disturbance moved across central North Carolina and interacted with moderate to strong instability to trigger scattered showers and thunderstorms. Several of these storms became severe and produced damaging winds and a few isolated severe hail reports.

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences

Although there were not a high number of historical lightning events reported in Wake County via NCDC data, it is a regular occurrence accompanied by thunderstorms. In fact, lightning events will assuredly happen on an annual basis, though not all events will cause damage. According to Vaisala's U.S. National Lightning Detection Network (NLDN®), Wake County is located in an area of the country that experienced an average of 4 to 5 lightning flashes per square kilometer per year between 1997 and 2010. Therefore, the probability of future events is highly likely (100 percent annual probability). It can be expected that future lightning events will continue to threaten life and cause minor property damages throughout the jurisdiction.

M.2.6 Severe Thunderstorm/High Wind

Location and Spatial Extent

A wind event is an atmospheric hazard, and thus has no geographic boundaries. It is typically a widespread event that can occur in all regions of the United States. However, thunderstorms are most common in the central and southern states because atmospheric conditions in those regions are favorable for generating these powerful storms. Also, Wake County typically experiences several straight-line wind events each year. These wind events can and have caused significant damage. It is assumed that Wake County has uniform exposure to an event and the spatial extent of an impact could be large.

Historical Occurrences

Severe storms were at least partially responsible for three disaster declarations in Wake County in 1988, 1998, and 2011.[5] According to NCDC, there have been 186 reported thunderstorm/high wind events since 1994 for high wind and since 1950 for thunderstorms.[6] These events caused over $300,000 (2013 dollars) in damages. **Table M.12** summarizes this information. **Table M.13** presents detailed high wind and thunderstorm wind event reports including date, magnitude, and associated damages for each event.[7]

TABLE M. 12: SUMMARY OF THUNDERSTORM/HIGH WIND OCCURRENCES IN WAKE COUNTY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013 dollars)
Unincorporated Wake County	186	1/2	$323,146

Source: National Climatic Data Center

TABLE M.13: HISTORICAL THUNDERSTORM/HIGH WIND OCCURRENCES IN WAKE COUNTY

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Wake County					
Wake County	6/15/1958	TSTM WIND	0 kts.	0/0	$0
Wake County	6/15/1958	TSTM WIND	0 kts.	0/0	$0
Wake County	6/21/1964	TSTM WIND	50 kts.	0/0	$0
Wake County	10/7/1965	TSTM WIND	0 kts.	0/0	$0
Wake County	7/14/1966	TSTM WIND	0 kts.	0/0	$0
Wake County	7/20/1970	TSTM WIND	0 kts.	0/0	$0
Wake County	8/3/1970	TSTM WIND	0 kts.	0/0	$0
Wake County	5/17/1973	TSTM WIND	0 kts.	0/0	$0
Wake County	5/28/1973	TSTM WIND	0 kts.	0/0	$0

[5] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.

[6] These thunderstorm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional thunderstorm events have occurred in Wake County. As additional local data becomes available, this hazard profile will be amended.

[7] The dollar amount of damages provided by NCDC is divided by the number of affected counties to reflect a damage estimate for the county.

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Wake County	8/12/1973	TSTM WIND	0 kts.	0/0	$0
Wake County	8/12/1973	TSTM WIND	0 kts.	0/0	$0
Wake County	6/23/1974	TSTM WIND	0 kts.	0/0	$0
Wake County	3/24/1975	TSTM WIND	0 kts.	0/0	$0
Wake County	3/24/1975	TSTM WIND	0 kts.	0/0	$0
Wake County	3/24/1975	TSTM WIND	0 kts.	0/0	$0
Wake County	10/9/1976	TSTM WIND	0 kts.	0/0	$0
Wake County	7/13/1977	TSTM WIND	0 kts.	0/0	$0
Wake County	2/11/1981	TSTM WIND	0 kts.	0/0	$0
Wake County	6/16/1982	TSTM WIND	0 kts.	0/0	$0
Wake County	7/3/1982	TSTM WIND	0 kts.	0/0	$0
Wake County	7/4/1982	TSTM WIND	0 kts.	0/0	$0
Wake County	8/23/1983	TSTM WIND	0 kts.	0/0	$0
Wake County	3/20/1984	TSTM WIND	52 kts.	0/0	$0
Wake County	3/20/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	3/21/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	3/21/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	4/4/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	5/8/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	5/8/1984	TSTM WIND	52 kts.	0/0	$0
Wake County	5/8/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	5/8/1984	TSTM WIND	0 kts.	0/0	$0
Wake County	4/16/1985	TSTM WIND	0 kts.	0/0	$0
Wake County	5/22/1985	TSTM WIND	0 kts.	0/0	$0
Wake County	6/5/1985	TSTM WIND	0 kts.	0/0	$0
Wake County	6/5/1985	TSTM WIND	0 kts.	0/0	$0
Wake County	2/6/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	2/6/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	3/13/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	7/22/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	7/26/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	7/26/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	7/29/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	8/2/1986	TSTM WIND	53 kts.	0/0	$0
Wake County	8/2/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	8/10/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	8/11/1986	TSTM WIND	0 kts.	0/0	$0
Wake County	4/12/1987	TSTM WIND	50 kts.	0/0	$0
Wake County	4/12/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	4/12/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	6/1/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	6/3/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	6/23/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	7/3/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	7/12/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	7/26/1987	TSTM WIND	0 kts.	0/0	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
Wake County	8/4/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	8/21/1987	TSTM WIND	0 kts.	0/0	$0
Wake County	5/23/1988	TSTM WIND	0 kts.	0/0	$0
Wake County	6/17/1988	TSTM WIND	0 kts.	0/0	$0
Wake County	6/20/1988	TSTM WIND	0 kts.	0/0	$0
Wake County	6/20/1988	TSTM WIND	0 kts.	0/0	$0
Wake County	6/20/1988	TSTM WIND	0 kts.	0/0	$0
Wake County	7/31/1988	TSTM WIND	0 kts.	0/0	$0
Wake County	2/21/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	2/21/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	3/18/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	4/25/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	4/27/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	5/5/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	5/6/1989	TSTM WIND	0 kts.	0/0	$0
Wake County	5/1/1990	TSTM WIND	0 kts.	0/0	$0
Wake County	6/22/1990	TSTM WIND	0 kts.	0/0	$0
Wake County	6/22/1990	TSTM WIND	0 kts.	0/0	$0
Wake County	6/22/1990	TSTM WIND	0 kts.	0/0	$0
Wake County	8/16/1990	TSTM WIND	0 kts.	0/0	$0
Wake County	4/8/1991	TSTM WIND	0 kts.	0/0	$0
Wake County	3/10/1992	TSTM WIND	0 kts.	0/0	$0
Wake County	3/10/1992	TSTM WIND	0 kts.	0/0	$0
Wake County	4/24/1992	TSTM WIND	0 kts.	0/0	$0
Wake County	8/12/1992	TSTM WIND	0 kts.	0/0	$0
Wake County	8/5/1994	THUNDERSTORM WINDS	0 kts.	0/0	$0
Wake County	5/19/1995	THUNDERSTORM WINDS	0 kts.	0/0	$68,275
Wake County	6/11/1995	THUNDERSTORM WINDS	60 kts.	0/0	$0
COUNTYWIDE	1/19/1996	TSTM WIND	0 kts.	0/0	$0
NEW HILL	4/15/1996	TSTM WIND	0 kts.	0/0	$16,574
SRN HALF	7/2/1996	TSTM WIND	0 kts.	0/0	$0
Wake County	4/1/1997	HIGH WIND	50 kts.	1/1	$0
Wake County	7/24/1997	HIGH WIND	50 kts.	0/0	$0
Wake County	2/3/1998	HIGH WIND	35 kts.	0/0	$0
Wake County	2/16/1998	HIGH WIND	52 kts.	0/0	$0
PURNELL	5/20/2000	TSTM WIND	50 kts.	0/0	$0
FALLS	8/10/2000	TSTM WIND	50 kts.	0/0	$0
FUQUAY SPGS	7/5/2002	TSTM WIND	50 kts.	0/0	$0
Wake County	3/7/2004	TSTM WIND	65 kts.	0/0	$7,030
Wake County	11/22/2006	HIGH WIND	38 kts.	0/0	$12,668
Wake County	4/16/2007	TSTM WIND	42 kts.	0/0	$0
Wake County	2/10/2008	TSTM WIND	43 kts.	0/0	$229
WILLIAMS XRDS	3/4/2008	TSTM WIND	61 kts.	0/0	$0
BAYLEAF	6/1/2008	TSTM WIND	50 kts.	0/0	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
BAYLEAF	6/1/2008	TSTM WIND	50 kts.	0/0	$0
MILLBROOK	6/27/2008	TSTM WIND	50 kts.	0/0	$0
PURNELL	6/29/2008	TSTM WIND	50 kts.	0/0	$0
PURNELL	6/29/2008	TSTM WIND	50 kts.	0/0	$0
CARPENTER	7/4/2008	TSTM WIND	50 kts.	0/0	$0
PET XRDS	7/22/2008	STRONG WIND	50 kts.	0/0	$0
BAYLEAF	8/15/2008	THUNDERSTORM WIND	50 kts.	0/0	$17,911
BRENTWOOD	8/20/2008	STRONG WIND	50 kts.	0/0	$0
Wake County	9/6/2008	THUNDERSTORM WIND	50 kts.	0/0	$14,926
Wake County	9/6/2008	STRONG WIND	39 kts.	0/0	$7,463
Wake County	1/7/2009	THUNDERSTORM WIND	55 kts.	0/0	$115,927
UPCHURCH	5/5/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
BROOKHAVEN	5/9/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
COLLEGE VIEW	5/9/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
LEESVILLE	5/9/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
ROYAL MILLS	5/9/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
SIX FORKS	5/9/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
PURNELL	6/17/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
WILDERS GROVE	7/1/2009	THUNDERSTORM WIND	50 kts.	0/0	$2,319
WILLOW SPGS	7/27/2009	THUNDERSTORM WIND	60 kts.	0/0	$0
WILLOW SPGS	7/27/2009	HIGH WIND	50 kts.	0/0	$0
BAYLEAF	8/11/2009	STRONG WIND	50 kts.	0/0	$0
WESTOVER	8/17/2009	HIGH WIND	50 kts.	0/0	$0
PURNELL	9/28/2009	THUNDERSTORM WIND	50 kts.	0/0	$0
ROCKTON	6/13/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
LEESVILLE	7/20/2010	THUNDERSTORM WIND	57 kts.	0/0	$0
SIX FORKS	7/20/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
MILLBROOK	7/29/2010	THUNDERSTORM WIND	50 kts.	0/0	$1,126
CARALEIGH	8/5/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
WILDERS GROVE	8/5/2010	THUNDERSTORM WIND	50 kts.	0/0	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
PURNELL	8/23/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
FRIENDSHIP	11/16/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
AUBURN	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
BARHAM	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
COLLEGE VIEW	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
KENNEBEC	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
ROCKTON	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
WAKE XRDS	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
WILDERS GROVE	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
WILDERS GROVE	11/17/2010	THUNDERSTORM WIND	50 kts.	0/0	$0
ROYAL MILLS	3/23/2011	THUNDERSTORM WIND	50 kts.	0/0	$21,855
BAYLEAF	6/10/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
ASBURY	6/20/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
BURT	6/21/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
MC CULLERS	6/27/2011	THUNDERSTORM WIND	54 kts.	0/0	$0
BONSAL	6/28/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
GREEN LEVEL	7/24/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
WILLIAMS XRDS	7/25/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
BROOKHAVEN	8/29/2011	THUNDERSTORM WIND	50 kts.	0/0	$0
WESTOVER	2/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
ASBURY	5/9/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
ASBURY	5/9/2012	THUNDERSTORM WIND	50 kts.	0/0	$2,122
MC CULLERS	5/9/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
ROYAL MILLS	5/23/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
WYATT	5/23/2012	THUNDERSTORM WIND	50 kts.	0/0	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
WAKE XRDS	6/1/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
PURNELL	6/29/2012	THUNDERSTORM WIND	50 kts.	0/0	$5,305
BARHAM	7/1/2012	THUNDERSTORM WIND	50 kts.	0/0	$1,061
BANKS	7/3/2012	THUNDERSTORM WIND	50 kts.	0/0	$2,122
CAMP POLK	7/3/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
MILLBROOK	7/3/2012	THUNDERSTORM WIND	50 kts.	0/0	$2,122
WILDERS GROVE	7/3/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
COLLEGE VIEW	7/4/2012	THUNDERSTORM WIND	50 kts.	0/0	$5,305
MILLBROOK	7/4/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
SIX FORKS	7/4/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
EAGLE ROCK	7/5/2012	THUNDERSTORM WIND	50 kts.	0/0	$3,183
MACEDONIA	7/5/2012	THUNDERSTORM WIND	50 kts.	0/0	$2,122
MILLBROOK	7/5/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
WILDERS GROVE	7/5/2012	THUNDERSTORM WIND	50 kts.	0/0	$3,183
MILLBROOK	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
ROCKTON	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
STARMOUNT	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
UPCHURCH	7/6/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
AUBURN	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$2,122
CAMP POLK	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
CAMP POLK	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
ECHO HGTS	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$2,122
LEESVILLE	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
METHOD	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$5,305
WILBON	7/24/2012	THUNDERSTORM WIND	50 kts.	0/0	$0

Location	Date	Type	Magnitude	Deaths/ Injuries	Property Damage*
CAMP POLK	7/28/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
FAWLERS XRDS	7/28/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
LEESVILLE	7/28/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
BAYLEAF	8/1/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
LASSITER	8/1/2012	THUNDERSTORM WIND	50 kts.	0/0	$0
BAYLEAF	8/8/2012	THUNDERSTORM WIND	50 kts.	0/0	$769
ROCKTON	9/18/2012	THUNDERSTORM WIND	50 kts.	0/0	$0

*Property damage is reported in 2013 dollars; All damage may not have been reported.
Source: National Climatic Data Center

Probability of Future Occurrences
Given the high number of previous events, it is certain that wind events, including straight-line wind and thunderstorm wind, will occur in the future. This results in a probability level of highly likely (100 percent annual probability) for future wind events for the entire jurisdiction.

M.2.7 Tornado

Location and Spatial Extent
Tornadoes occur throughout the state of North Carolina, and thus in Wake County. Tornadoes typically impact a relatively small area, but damage may be extensive. Event locations are completely random and it is not possible to predict specific areas that are more susceptible to tornado strikes over time. Therefore, it is assumed that Wake County is uniformly exposed to this hazard.

Historical Occurrences
Tornadoes are becoming a more and more common occurrence in central and eastern North Carolina as demonstrated by a recent outbreak of tornadoes in the spring of 2011. According to the National Climatic Data Center, there have been twenty-one recorded tornado events in unincorporated Wake County since 1956 (**Table M.14**), resulting in over $700 million (2013 dollars) in property damages.[8] Detailed information on these events can be found in **Table M.15**. The largest magnitude of these tornadoes was a F4 in intensity, although an F5 event is possible. It is important to note that only tornadoes that have been reported are factored into this risk assessment. It is likely that a high number of occurrences have gone unreported over the past 50 years.

[8] These tornado events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is likely that additional tornadoes have occurred in Wake County. As additional local data becomes available, this hazard profile will be amended.

TABLE M.14: SUMMARY OF TORNADO OCCURRENCES IN WAKE COUNTY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Unincorporated Wake County	21	7/184	$700,021,569

Source: National Climatic Data Center

TABLE M.15: HISTORICAL TORNADO IMPACTS IN WAKE COUNTY

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
Wake County					
Wake County	5/12/1950	F0	0/0	$0	
Wake County	5/12/1950	F1	0/0	$0	
Wake County	4/5/1952	F2	0/0	$245,175	
Wake County	3/18/1956	F1	0/1	$239,506	
Wake County	3/18/1956	F2	0/0	$23,951	
Wake County	11/2/1966	F2	0/9	$2,011,388	
Wake County	5/14/1967	F0	0/0	$0	
Wake County	7/11/1967	F1	0/0	$194,529	
Wake County	5/28/1973	F1	0/0	$146,412	
Wake County	5/29/1973	F0	0/0	$146,412	
Wake County	12/31/1975	F1	0/0	$12,080	
Wake County	5/7/1977	F0	0/0	$10,734	
Wake County	2/11/1981	F2	0/2	$715,623	
Wake County	6/13/1982	F1	1/0	$67,373	
Wake County	6/16/1982	F2	0/0	$673,733	
Wake County	3/14/1986	F1	0/0	$59,362	
Wake County	3/26/1988	F0	2/105		
Wake County	11/28/1988	F4	0/0	$569,530,309	
Wake County	10/23/1990	F1	0/0	$0	
ROCKTON	4/25/2010	F0	0/0	$281,377	EPISODE NARRATIVE: An isolated cell formed over Moore County in advance of a strong surface cold front in a high shear and moderate CAPE environment. The lone storm strengthened into a super cell over central Wake County before it produced a weak EF0 tornado near Zebulon in eastern Wake County.
BURT	4/16/2011	F3	4/67	$125,663,605	EPISODE NARRATIVE: A strong storm system that had a history of producing deadly tornadoes across Oklahoma and the deep south on the 14th and 15th weakened as it crossed the southern Appalachians during the early morning hours of the 16th. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic

	Date	Magnitude	Deaths/ Injuries	Property Damage*	Details
					supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries

*Property Damage is reported in 2013 dollars.
Source: NCDC

2011 Tornadoes- April 16, 2011
In 2011, the county and all of its jurisdictions were impacted by one of the worst tornado-related events in the county's recorded history. A squall line descended the Blue Ridge by the late morning hours, and rapidly intensified |as it moved east into the central Piedmont of North Carolina, with four long live tornadic supercells evolving from the linear convective segment. These tornadic supercells went on to produce 9 tornadoes in the Raleigh CWA, including 2 EF3s, and 4 EF2s. The tornadoes left 6 dead with approximately 275 injuries.

Probability of Future Occurrences
According to historical information, tornado events are not an annual occurrence for the jurisdiction. However, tornadoes are a somewhat common occurrence in the county as it is located in an area of relatively flat topography in the southeastern United States. While the majority of the reported tornado events are small in terms of size, intensity, and duration, they do pose a significant threat should Wake County experience a direct tornado strike. The probability of future tornado occurrences affecting Wake County is likely (10-100 percent annual probability).

M.2.8 Winter Storm and Freeze

Location and Spatial Extent
Nearly the entire continental United States is susceptible to winter storm and freeze events. Some ice and winter storms may be large enough to affect several states, while others might affect limited, localized areas. The degree of exposure typically depends on the normal expected severity of local winter weather. Wake County is accustomed to smaller scale severe winter weather conditions and often receives severe winter weather during the winter months. Given the atmospheric nature of the hazard, the entire jurisdiction has uniform exposure to a winter storm.

Historical Occurrences
Severe winter weather has resulted in six disaster declarations in Wake County. This includes ice storms in 1968 and 2002, snow storms in 1977, 1993, and 1996, and a severe winter storm in 2000. [9] According to the National Climatic Data Center, there have been 30 recorded winter storm events in Wake County since 1993 (**Table M.16**).[10] These events resulted in over $900,000 (2013 dollars) in damages.

[9] A complete listing of historical disaster declarations can be found in Section 4: *Hazard Profiles*.
[10] These ice and winter storm events are only inclusive of those reported by the National Climatic Data Center (NCDC). It is certain that additional winter storm conditions have affected Wake County.

TABLE M.16: SUMMARY OF WINTER STORM EVENTS IN WAKE COUNTY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Unincorporated Wake County	30	2/10*	$900,752

Source: National Climatic Data Center

There have been several severe winter weather events to impact Wake County. The text below describes one of the major events and associated impacts on the county. Similar impacted can be expected with severe winter weather.

1996 Winter Storm

This storm left two feet of snow and several thousand citizens without power for up to nine days. Although shelters were opened, some roads were impassible for up to four days. This event caused considerable disruption to business, industry, schools, and government services.

Winter storms throughout the planning area have several negative externalities including hypothermia, cost of snow and debris cleanup, business and government service interruption, traffic accidents, and power outages. Furthermore, citizens may resort to using inappropriate heating devices that could to fire or an accumulation of toxic fumes.

Probability of Future Occurrences

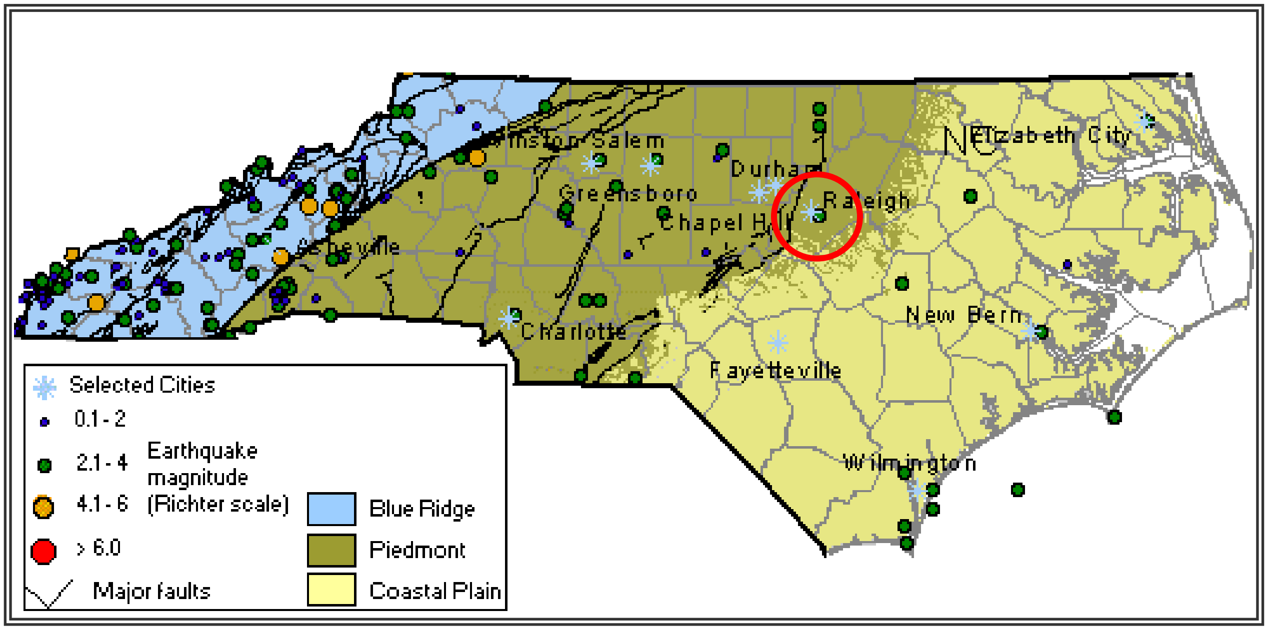
Winter storm events will remain a somewhat regular occurrence in Wake County due to location and latitude. According to historical information, Wake County experiences an average of 1-2 winter storm events each year. Therefore, the annual probability is likely (10-100 percent).

M.2.9 Earthquake

Location and Spatial Extent

Approximately two-thirds of North Carolina is subject to earthquakes, with the western and southeast region most vulnerable to a very damaging earthquake. The state is affected by both the Charleston Fault in South Carolina and New Madrid Fault in Tennessee. Both of these faults have generated earthquakes measuring greater than 8 on the Richter Scale during the last 200 years. In addition, there are several smaller fault lines throughout North Carolina. **Figure M.2** is a map showing geological and seismic information for North Carolina.

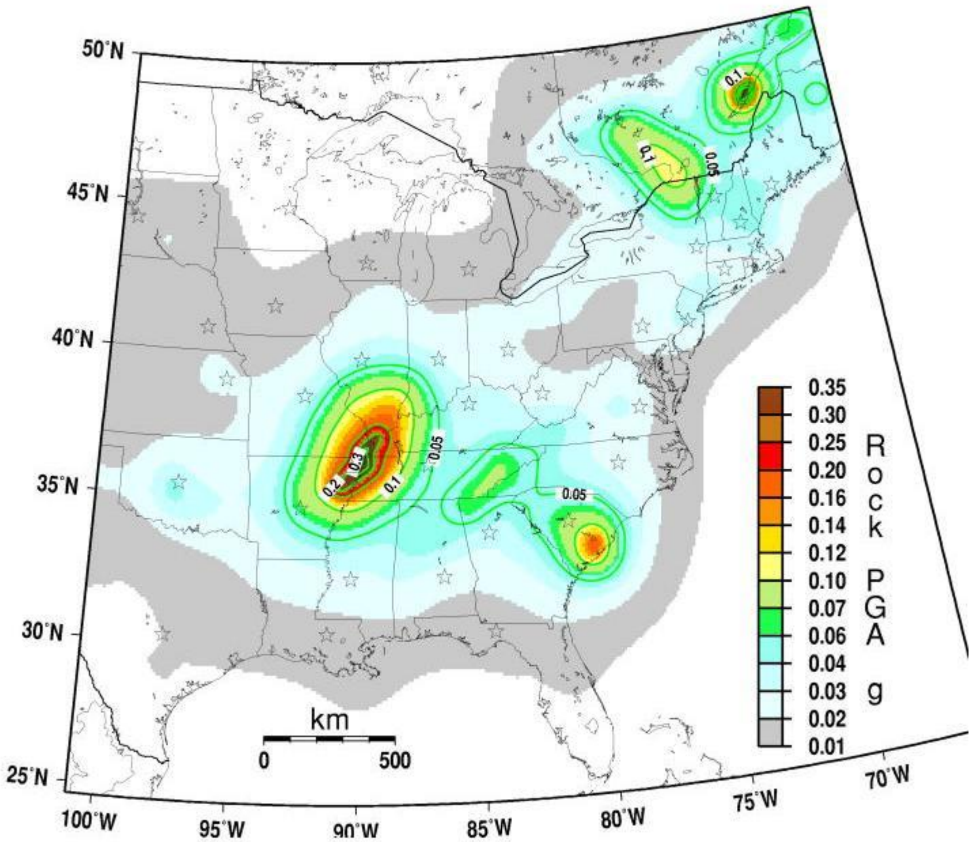
FIGURE M.2: GEOLOGICAL AND SEISMIC INFORMATION FOR NORTH CAROLINA



Source: North Carolina Geological Survey

Figure M.3 shows the intensity level associated with Wake County, based on the national USGS map of peak acceleration with 10 percent probability of exceedance in 50 years. It is the probability that ground motion will reach a certain level during an earthquake. The data show peak horizontal ground acceleration (the fastest measured change in speed, for a particle at ground level that is moving horizontally due to an earthquake) with a 10 percent probability of exceedance in 50 years. The map was compiled by the U.S. Geological Survey (USGS) Geologic Hazards Team, which conducts global investigations of earthquake, geomagnetic, and landslide hazards. According to this map, Wake County lies within an approximate zone of level “2” to “3” ground acceleration. This indicates that the county exists within an area of moderate seismic risk.

FIGURE M.3: PEAK ACCELERATION WITH 10 PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS



Source: USGS, 2008

Historical Occurrences

Although no earthquakes are known to have occurred in unincorporated Wake County since 1874, several have occurred within the incorporated areas of county boundary. The strongest of these measured a VIII on the Modified Mercalli Intensity (MMI) scale. **Table M.17** provides a summary of earthquake events reported by the National Geophysical Data Center between 1638 and 1985. **Table M.18** presents a detailed occurrence of each event including the date, distance for the epicenter, and Modified Mercalli Intensity (if known). [11]

TABLE M.17: SUMMARY OF SEISMIC ACTIVITY IN WAKE COUNTY

Location	Number of Occurrences	Greatest MMI Reported	Richter Scale Equivalent
Unincorporated Wake County	--	--	--

Source: National Geophysical Data Center

[11] Due to reporting mechanisms, not all earthquakes events were recorded during this time. Furthermore, some are missing data, such as the epicenter location, due to a lack of widely used technology. In these instances, a value of "unknown" is reported.

TABLE M.18: SIGNIFICANT SEISMIC EVENTS IN WAKE COUNTY (1638 -1985)

Location	Date	Epicentral Distance (km)	Magnitude	MMI (magnitude)
Wake County				
None reported				

Source: National Geophysical Data Center

In addition to those earthquakes specifically affecting Wake County, a list of earthquakes that have caused damage throughout North Carolina is presented below in **Table M.19.**

TABLE M.19: EARTHQUAKES WHICH HAVE CAUSED DAMAGE IN NORTH CAROLINA

Date	Location	Richter Scale (Magnitude)	MMI (Intensity)	MMI in North Carolina
12/16/1811 - 1	NE Arkansas	8.5	XI	VI
12/16/1811 - 2	NE Arkansas	8.0	X	VI
12/18/1811 - 3	NE Arkansas	8.0	X	VI
01/23/1812	New Madrid, MO	8.4	XI	VI
02/071812	New Madrid, MO	8.7	XII	VI
04/29/1852	Wytheville, VA	5.0	VI	VI
08/31/1861	Wilkesboro, NC	5.1	VII	VII
12/23/1875	Central Virginia	5.0	VII	VI
08/31/1886	Charleston, SC	7.3	X	VII
05/31/1897	Giles County, VA	5.8	VIII	VI
01/01/1913	Union County, SC	4.8	VII	VI
02/21/1916*	Asheville, NC	5.5	VII	VII
07/08/1926	Mitchell County, NC	5.2	VII	VII
11/03/1928*	Newport, TN	4.5	VI	VI
05/13/1957	McDowell County, NC	4.1	VI	VI
07/02/1957*	Buncombe County, NC	3.7	VI	VI
11/24/1957*	Jackson County, NC	4.0	VI	VI
10/27/1959 **	Chesterfield, SC	4.0	VI	VI
07/13/1971	Newry, SC	3.8	VI	VI
11/30/1973*	Alcoa, TN	4.6	VI	VI
11/13/1976	Southwest Virginia	4.1	VI	VI
05/05/1981	Henderson County, NC	3.5	VI	VI

*This event is accounted for in the Wake County occurrences.
** Conflicting reports on this event, intensity in North Carolina could have been either V or VI
Source: This information compiled by Dr. Kenneth B. Taylor and provided by Tiawana Ramsey of NCEM. Information was compiled from the National Earthquake Center, Earthquakes of the US by Carl von Hake (1983), and a compilation of newspaper reports in the Eastern Tennessee Seismic Zone compiled by Arch Johnston, CERI, Memphis State University (1983).

Probability of Future Occurrences

The probability of significant, damaging earthquake events affecting Wake County is unlikely. However, it is possible that future earthquakes resulting in light to moderate perceived shaking and damages ranging from none to very light will affect the county. The annual probability level for the county is estimated between 1 and 10 percent (possible).

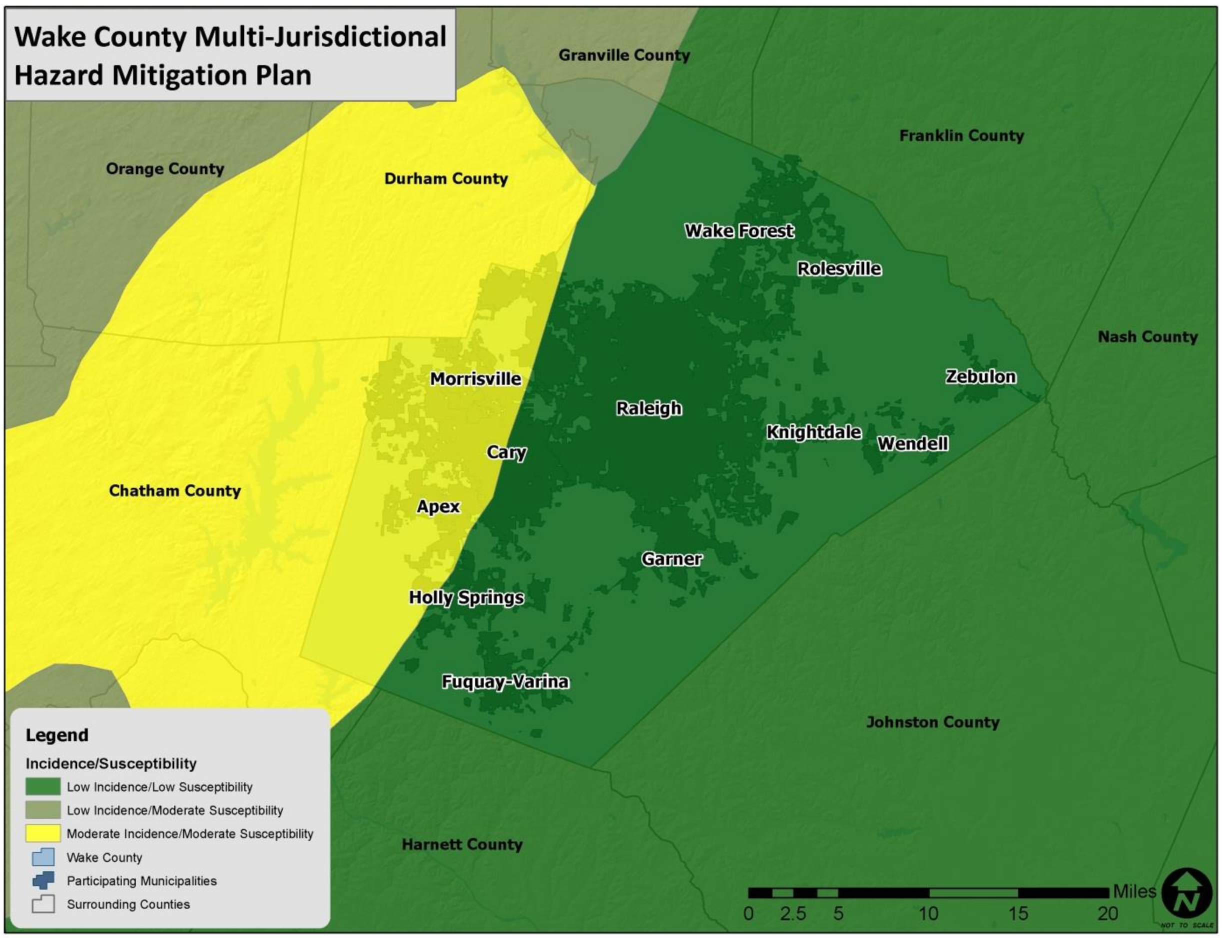
M.2.10 Landslide

Location and Spatial Extent

Landslides occur along steep slopes when the pull of gravity can no longer be resisted (often due to heavy rain). Human development can also exacerbate risk by building on previously undevelopable steep slopes and constructing roads by cutting through hills or mountains. Landslides are possible throughout Wake County, although the overall risk is relatively low.

According to **Figure M.4** below, the majority of the county has low landslide activity. However there is a small area along the western border of the county that has a moderate incidence and moderate susceptibility. In all other areas, there is low susceptibility.

FIGURE M.4: LANDSLIDE SUSCEPTIBILITY AND INCIDENCE MAP OF WAKE COUNTY



Source: USGS

Historical Occurrences

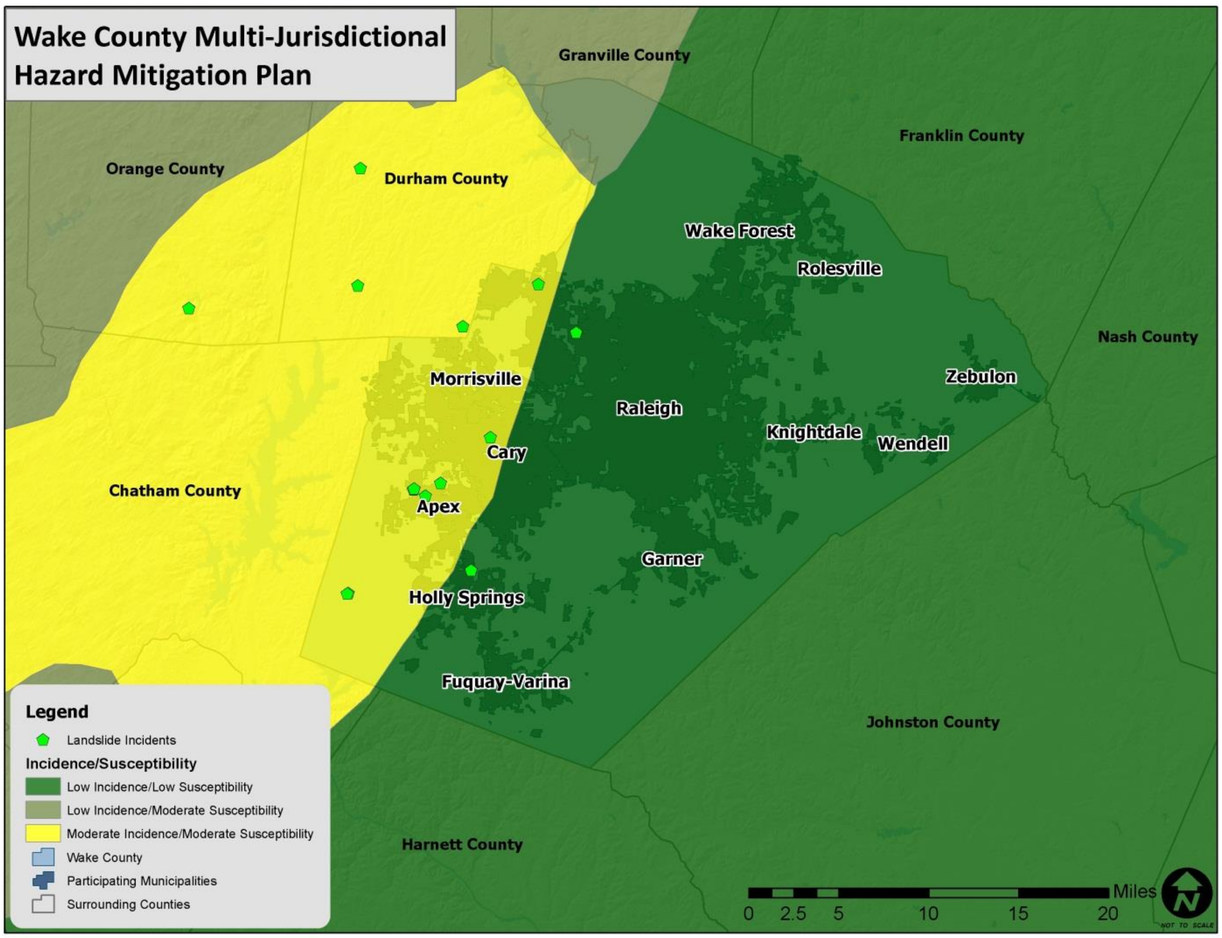
Steeper topography in some areas of Wake County make the planning area susceptible to landslides. Most landslides are caused by heavy rainfall in the area. Building on steep slopes that was not previously possible also contributes to risk. **Table M.20** presents a summary of the landslide occurrence events as provided by the North Carolina Geological Survey[12]. The georeferenced locations of the landslide events presented in the aforementioned tables are presented in **Figure M.5**. Some incidence mapping has also been completed throughout the western portion of North Carolina though none has been done in this area of the state. Therefore, it should be noted that more incidents than what is reported may have occurred in Wake County.

TABLE M.20: SUMMARY OF LANDSLIDE ACTIVITY IN WAKE COUNTY

Location	Number of Occurrences
Unincorporated Wake County	4

Source: North Carolina Geological Survey

FIGURE M.5: LOCATION OF PREVIOUS LANDSLIDE OCCURRENCES IN WAKE COUNTY



Source: North Carolina Geological Survey

Probability of Future Occurrences

Based on historical information and the USGS susceptibility index, the probability of future landslide events is possible (1 to 10 percent probability). Local conditions may become more favorable for

[12] It should be noted that the North Carolina Geological Survey (NCGS) emphasized the dataset provided was incomplete. Therefore, there may be additional historical landslide occurrences. Furthermore, dates were not included for every event. The earliest date reported was 1940. No damage information was provided by NCGS.

landslides due to heavy rain, for example. This would increase the likelihood of occurrence. It should also be noted that some areas in Wake County have greater risk than others given factors such as steepness on slope and modification of slopes.

M.2.11 Dam and Levee Failure

Location and Spatial Extent

The North Carolina Division of Land Resources provides information on dams, including a hazard potential classification. There are three hazard classifications—high, intermediate, and low—that correspond to qualitative descriptions and quantitative guidelines. **Table M.21** explains these classifications.

TABLE M.21: NORTH CAROLINA DAM HAZARD CLASSIFICATIONS

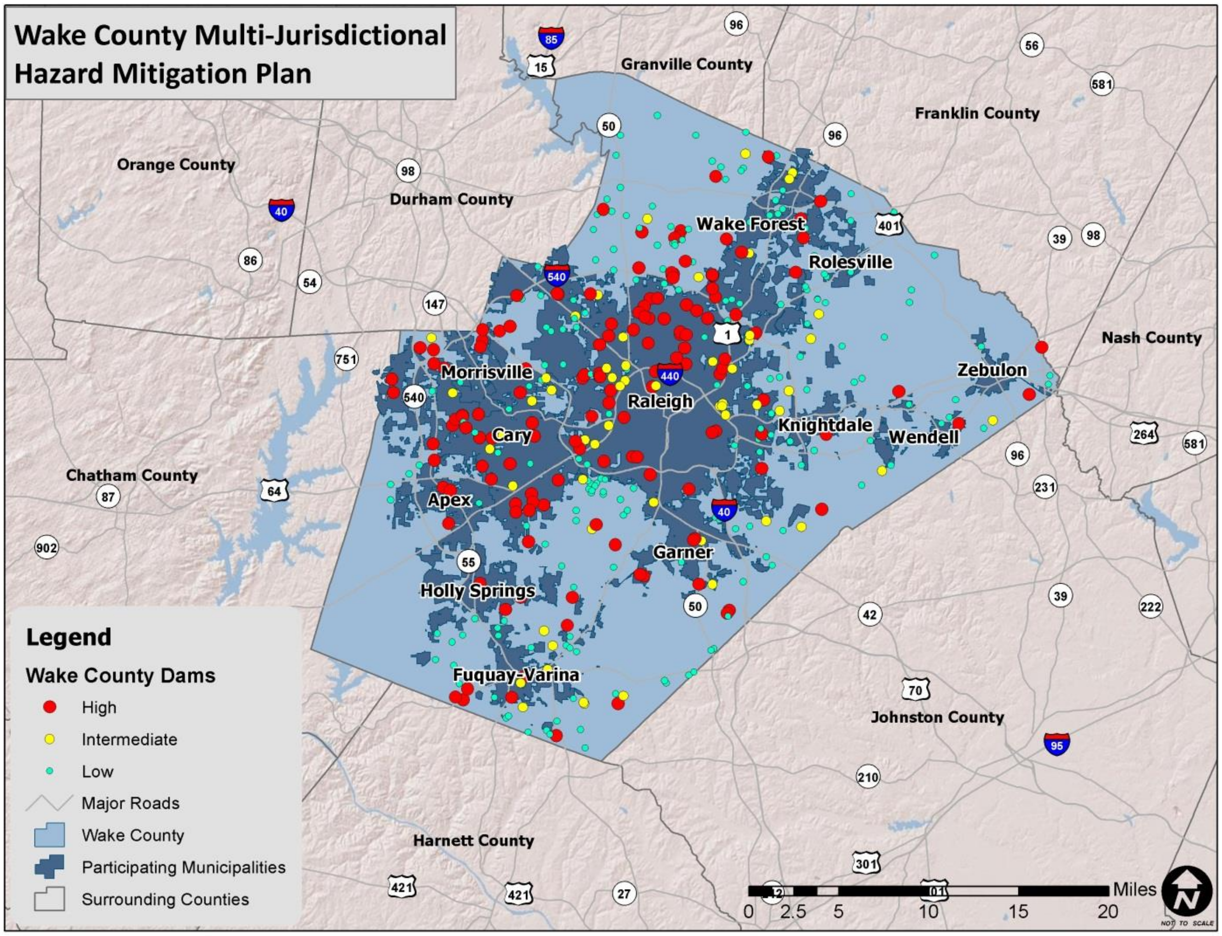
Hazard Classification	Description	Quantitative Guidelines
Low	Interruption of road service, low volume roads	Less than 25 vehicles per day
	Economic damage	Less than $30,000
Intermediate	Damage to highways, Interruption of service	25 to less than 250 vehicles per day
	Economic damage	$30,000 to less than $200,000
High	Loss of human life*	Probable loss of 1 or more human lives
	Economic damage	More than $200,000
	*Probable loss of human life due to breached roadway or bridge on or below the dam.	250 or more vehicles per day

Source: North Carolina Division of Land Resources

According to the North Carolina Division of Land Management there are 220 dams in unincorporated Wake County.[13] **Figure M.6** shows the dam location and the corresponding hazard ranking for each. Of these dams, 44 are classified as high hazard potential. These high hazard dams are listed in **Table M.22**.

[13] The February 8, 2012 list of high hazard dams obtained from the North Carolina Division of Energy, Mineral, and Land Resources (http://portal.ncdenr.org/web/lr/dams) was reviewed and amended by local officials to the best of their knowledge.

FIGURE M.6: WAKE COUNTY DAM LOCATION AND HAZARD RANKING



Source: North Carolina Division of Land Resources, 2012

TABLE M.22: WAKE COUNTY HIGH HAZARD DAMS

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Wake County				
Falls Of The Neuse Dam	High	0	1128100	Federal
Lake Benson Dam	High	463	7200	Local Gov
Crabtree Dam 20-A	High	0	2500	Local Gov
Crabtree Creek Dam 5-A	High	0	3010	Local Gov
Garner Ww Lagoon #1	High	25	394	Local Gov
Garner Ww Lagoon #2	High	25	306	Local Gov
Neuse River Waste Water Treatment Plant Equalization Basin	High	7.5	114	Local Gov
Bunn Lake Dam	High	120	975	Private
Johnson Pond Dam	High	9	95	Private
Crossgate Lake Dam #1	High	13.1	207	Private
Crossgate Dam #2	High	0	40	Private

Dam Name	Hazard Potential	Surface Area (acres)	Max Capacity (Ac-ft)	Owner Type
Holding Lake Dam	High	11	145	Private
Panther Lake Dam	High	82	253	Private
Sunset Lake Dam	High	98.1	750	Private
Robertson'S Pond	High	25	259	Private
Rdu Wastewater Dam	High	1.6	22.5	Private
Rtp South Dam	High	77	708	Private
Crooked Creek	High	0	40	Private
Pendleton Lake	High	0	10	Private
Johnson Pond Dam	High	0	5	Private
Coachman Trail Lake Dam Lower	High	2	93	Private
Stonebridge Lake Dam	High	0	45	Private
Herndon Pond Dam	High	0	22	Private
Springdale Estates Upper Dam	High	0	75	Private
Coachman Trail Lake Dam Upper	High	0	180	Private
Byrd Dam	High	1	10	Private
Fuller Lake Dam	High	0	70	Private
Bailey Dam	High	6	76	Private
Marshall Pond #2	High	4	59	Private
Howell Dam	High	3	36	Private
Manchester Dam	High	0	88	Private
Crossgate Dam #3	High	0	12	Private
Chateau Lapointe Dam H	High	0	90	Private
Cozart Pond Dam	High	2	0	Private
Underwood Pond Dam	High	4	27	Private
Betts Pond Dam	High	5	40	Private
Breckenridge Recreation Center Dam	High	3	38	Private
Hasentree Golf Communtiy Dam	High	0	139	Private
RTP W-5 Dam	High	47	700	Private
State Fair H & L Dam	High	6	78	State
Lake Wheeler Dam	High	560	10800	Utility
Burnside Drive Dam	High	3	12	
Seymour Farms Pond Dam	High	0.7	7	
Rosewood Subdivision Dam	High	1	6	

Source: North Carolina Division of Land Resources, 2012

It should also be noted that the North Carolina dam classification regulations were recently updated. As a result of the change, more dams are generally classified as high hazard.

Historical Occurrences

Four dam breaches were reported in unincorporated Wake County but none have been significant. **Table M.23** displays the classification of each dam at time of failure and the main cause of the damage.

TABLE 5.23: HISTORICAL DAM FAILURES IN WAKE COUNTY

Name	Location	Class at Time of Failure	Current Class	Cause of Failure
Cedar Hills*	Wake County	Intermediate	High	Heavy rain (mid 1970s)
Coachman's Trail Lower	Wake County	High	High	Heavy rain (late 1970s)
Beaman's Lake***	Wake County	Intermediate	Intermediate	Heavy rain (late 1980s)
Yates Mill Pond	Wake County	Intermediate	Intermediate	Hurricane Fran (1996)

*High due to downstream development
**High due to increased traffic on downstream road
***Exempt due to dam height

Probability of Future Occurrences

Given the current dam inventory and historic data, a dam breach is unlikely (less than 1 percent annual probability) in the future. However, as has been demonstrated in the past, regular monitoring is necessary to prevent these events.

M.2.12 Erosion

Location and Spatial Extent

Erosion in Wake County is typically caused by flash flooding events. Unlike coastal areas, where the soil is mainly composed of fine grained particles such as sand, Wake County soils have greater organic matter content. Furthermore, vegetation also helps to prevent erosion in the area. Erosion occurs in Wake County, particularly along the banks of rivers and streams, but it is not an extreme threat. No areas of concern were reported by the planning committee.

Historical Occurrences

Several sources were vetted to identify areas of erosion in Wake County. This includes searching local newspapers, interviewing local officials, and reviewing the previous hazard mitigation plan. Little information could be found and erosion was not addressed in the previous Wake County hazard mitigation plan.

Probability of Future Occurrences

Erosion remains a natural, dynamic, and continuous process for Wake County, and it will continue to occur. The annual probability level assigned for erosion is possible (between 1 and 10 percent annually).

M.2.13 Flood

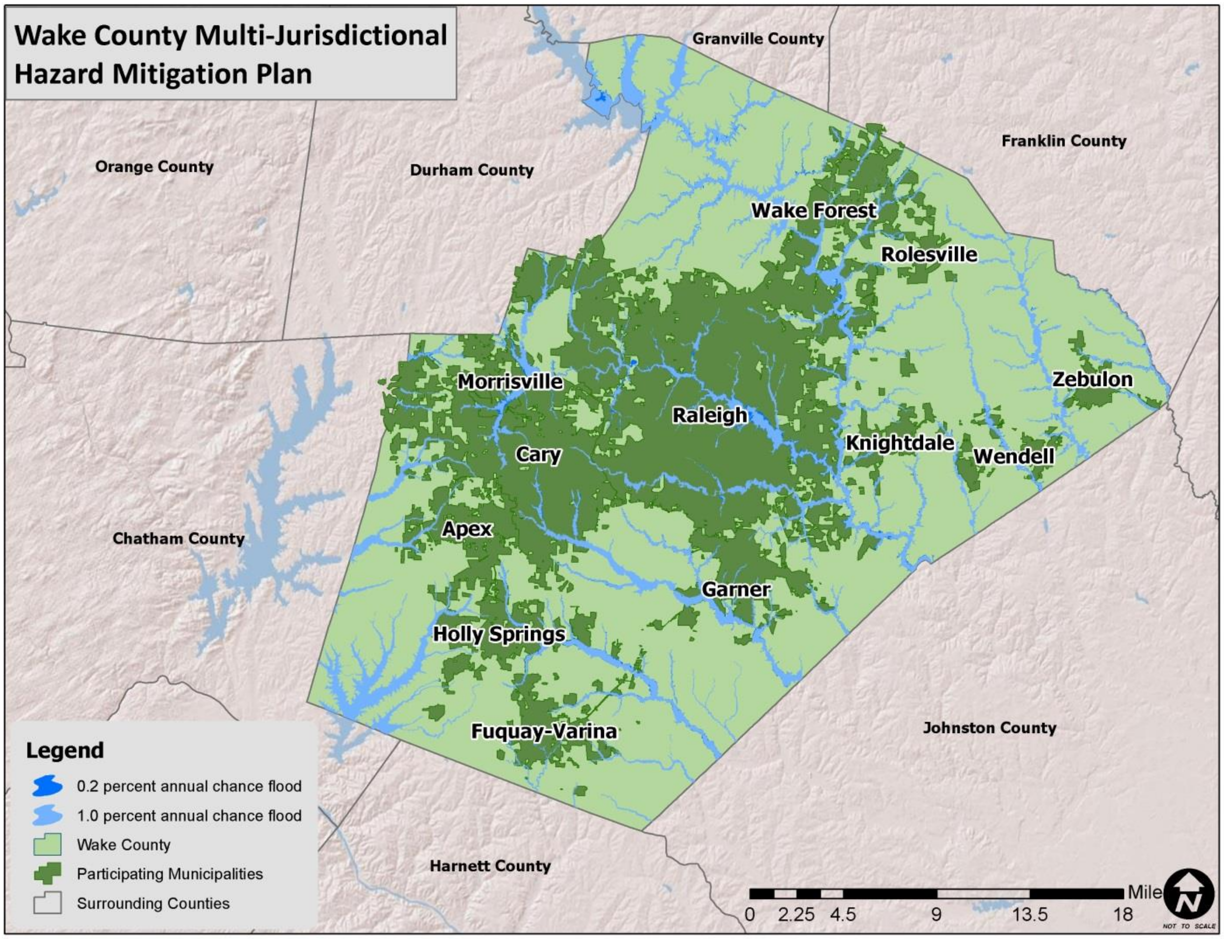
Location and Spatial Extent

There are areas in Wake County that are susceptible to flood events. Special flood hazard areas in the jurisdiction were mapped using Geographic Information System (GIS) and FEMA Digital Flood Insurance Rate Maps (DFIRM).[14] This includes Zone A (1-percent annual chance floodplain), Zone AE (1-percent annual chance floodplain with elevation), Zone X500 (0.2-percent annual chance floodplain). According to GIS analysis, in unincorporated Wake County, there are 55 square miles of land in zones A and AE (1-percent annual chance floodplain/100-year floodplain).

[14] The county-level DFIRM data used for Wake County were updated in 2010.

It is important to note that while FEMA digital flood data is recognized as best available data for planning purposes, it does not always reflect the most accurate and up-to-date flood risk. Flooding and flood-related losses often do occur outside of delineated special flood hazard areas. **Figure M.7** illustrates the location and extent of currently mapped special flood hazard areas for Wake County based on best available FEMA Digital Flood Insurance Rate Map (DFIRM) data.

FIGURE M.7: SPECIAL FLOOD HAZARD AREAS IN WAKE COUNTY



Source: Federal Emergency Management Agency

Historical Occurrences

Information from the National Climatic Data Center was used to ascertain historical flood events. The National Climatic Data Center reported a total of 43 events in unincorporated Wake County since 1993.[15] A summary of these events is presented in **Table M.24**. These events accounted for over $200,000 (2013 dollars) in property damage in the unincorporated county.[16] Specific information on flood events, including date, type of flooding, and deaths and injuries, can be found in **Table M.25**.

[15] These events are only inclusive of those reported by NCDC. It is likely that additional occurrences have occurred and have gone unreported.
[16] The total damage amount was averaged over the number of affected counties when multiple counties were involved in the flood event.

TABLE M.24: SUMMARY OF FLOOD OCCURRENCES IN WAKE COUNTY

Location	Number of Occurrences	Deaths/Injuries	Property Damage (2013)
Unincorporated Wake County	43	0/0	$220,101

Source: National Climatic Data Center

TABLE M.25: HISTORICAL FLOOD EVENTS IN WAKE COUNTY

	Date	Type	Deaths/ Injuries	Property Damage*
Wake County				
SRN	10/5/1995	FLASH FLOOD	0/0	$0
Northern	6/24/1995	FLASH FLOOD	0/0	$85,344
COUNTYWIDE	7/24/1997	FLASH FLOOD	0/0	$0
COUNTYWIDE	9/27/1999	FLASH FLOOD	0/0	$0
COUNTYWIDE	9/15/1999	FLASH FLOOD	0/0	$0
COUNTYWIDE	9/5/1999	FLASH FLOOD	0/0	$0
COUNTYWIDE	9/28/1999	FLASH FLOOD	0/0	$0
COUNTYWIDE	6/16/2001	FLASH FLOOD	0/0	$0
SOUTH PORTION	7/9/2001	FLASH FLOOD	0/0	$0
SOUTH PORTION	7/4/2001	FLASH FLOOD	0/0	$0
EAST PORTION	8/1/2003	FLASH FLOOD	0/0	$0
CENTRAL PORTION	8/8/2003	FLASH FLOOD	0/0	$0
CENTRAL PORTION	8/8/2003	FLASH FLOOD	0/0	$0
COUNTYWIDE	8/12/2004	FLASH FLOOD	0/0	$0
COUNTYWIDE	6/14/2006	FLASH FLOOD	0/0	$0
BRENTWOOD	4/27/2008	FLASH FLOOD	0/0	$0
MILLBROOK	4/27/2008	FLASH FLOOD	0/0	$0
MILLBROOK	9/6/2008	FLASH FLOOD	0/0	$119,405
ECHO HGTS	8/30/2008	FLASH FLOOD	0/0	$0
CARIO	8/28/2008	FLASH FLOOD	0/0	$0
ASBURY	5/5/2009	FLOOD	0/0	$0
MILLBROOK	5/5/2009	FLASH FLOOD	0/0	$0
BRENTWOOD	5/5/2009	FLASH FLOOD	0/0	$0
COLLEGE VIEW	12/2/2009	FLASH FLOOD	0/0	$0
CAMP POLK	12/2/2009	FLASH FLOOD	0/0	$0
WESTOVER	12/2/2009	FLASH FLOOD	0/0	$0
CARALEIGH	1/25/2010	FLASH FLOOD	0/0	$0
WESTOVER	6/16/2009	FLASH FLOOD	0/0	$0
WILLOW	9/22/2009	FLASH FLOOD	0/0	$0
CARALEIGH	8/24/2010	FLASH FLOOD	0/0	$0
LEESVILLE	8/5/2010	FLASH FLOOD	0/0	$0
ASBURY	6/1/2010	FLASH FLOOD	0/0	$0
WILLIAMS XRDS	9/30/2010	FLASH FLOOD	0/0	$0
STARMOUNT	8/6/2011	FLASH FLOOD	0/0	$0
COLLEGE VIEW	9/21/2011	FLASH FLOOD	0/0	$5,464
MILLBROOK	7/30/2012	FLASH FLOOD	0/0	$0
MILLBROOK	9/6/2012	FLASH FLOOD	0/0	$0

	Date	Type	Deaths/ Injuries	Property Damage*
MILLBROOK	9/18/2012	FLASH FLOOD	0/0	$0
MILLBROOK	9/8/2012	FLASH FLOOD	0/0	$9,888
COLLEGE VIEW	9/8/2012	FLASH FLOOD	0/0	$0

Source: National Climatic Data Center

Historical Summary of Insured Flood Losses

According to FEMA flood insurance policy records as of December 2013, there have been 62 flood losses reported in unincorporated Wake County through the National Flood Insurance Program (NFIP) since 1978. A summary of these figures for the jurisdiction is provided in **Table M.26**. It should be emphasized that these numbers include only those losses to structures that were insured through the NFIP policies, and for losses in which claims were sought and received. It is likely that additional instances of flood loss in Wake County were either uninsured, denied claims payment, or not reported.

TABLE M.26: SUMMARY OF INSURED FLOOD LOSSES IN WAKE COUNTY

Location	Flood Losses	Claims Payments
Unincorporated Wake County	62	$787,324

Source: FEMA, NFIP

Repetitive Loss Properties

FEMA defines a repetitive loss property as any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. Currently there are over 140,000 repetitive loss properties nationwide.

As of July 2013, there are 5 non-mitigated repetitive loss properties located in unincoporated Wake County, which accounted for 17 losses and $316,761 in claims payments under the NFIP. Without mitigation, repetitive loss properties will likely continue to experience flood losses. **Table M.27** presents detailed information on repetitive loss properties and NFIP claims and policies for Wake County.

TABLE M.27: SUMMARY OF REPETITIVE LOSS PROPERTIES IN WAKE COUNTY

Location	Number of Properties	Types of Properties	Number of Losses	Building Payments	Content Payments	Total Payments	Average Payment
Unincorporated Wake County	5	4 single family, 1 multi-family residential	17	$260,683	$56,078	$316,761	$18,633

Source: National Flood Insurance Program

Probability of Future Occurrences

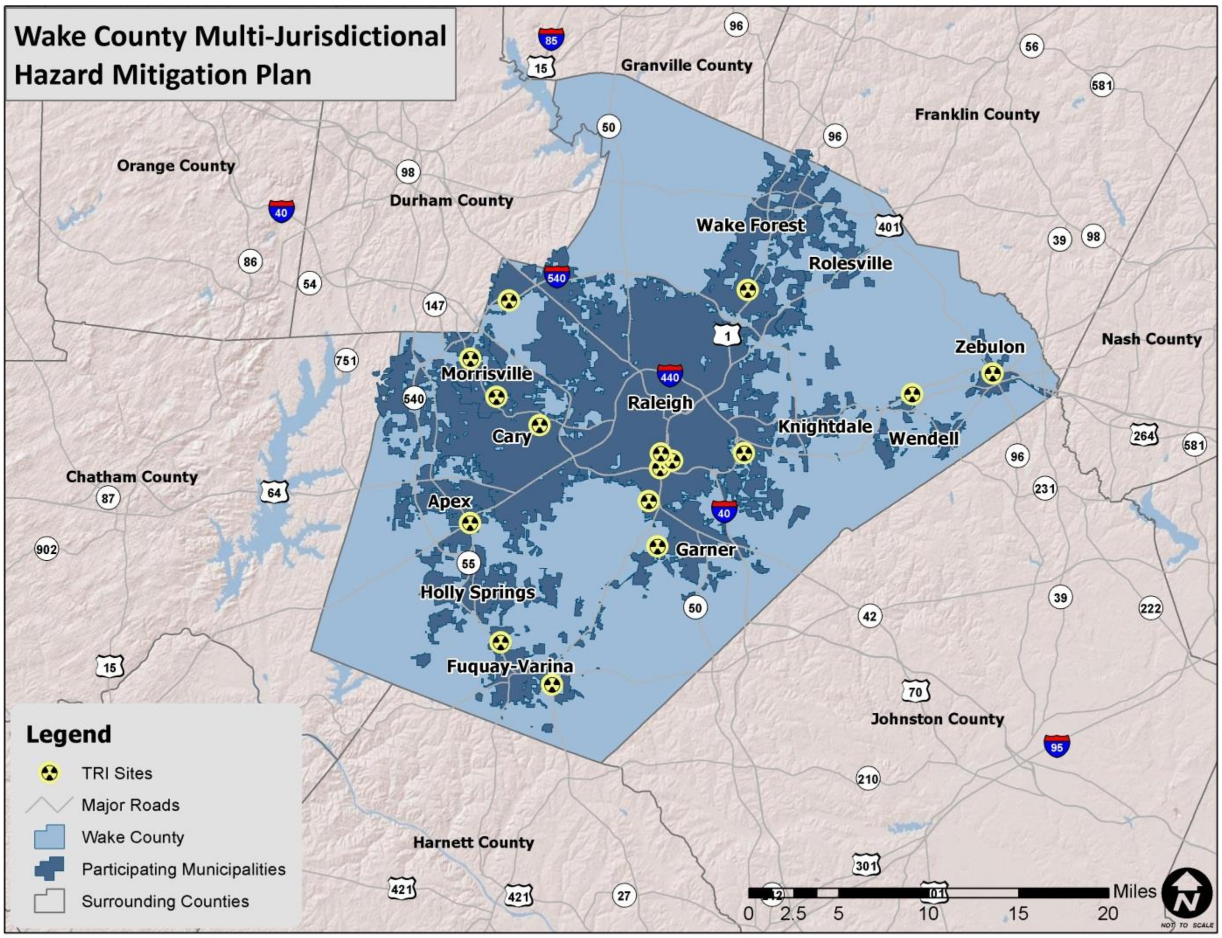
Flood events will remain a threat in areas prone to flooding in Wake County, and the probability of future occurrences will remain likely (between 10 and 100 percent annual probability) The probability of future flood events based on magnitude and according to best available data is illustrated in the figures above**,** which indicates those areas susceptible to the 1-percent annual chance flood (100-year floodplain) and the 0.2-percent annual chance flood (500-year floodplain).

M.2.14 Hazardous Materials Incidents

Location and Spatial Extent

As a result of the 1986 Emergency Planning and Community Right to Know Act (EPCRA), the Environmental Protection Agency provides public information on hazardous materials. One facet of this program is to collect information from industrial facilities on the releases and transfers of certain toxic agents. This information is then reported in the Toxic Release Inventory (TRI). TRI sites indicate where such activity is occurring. Unincorporated Wake County has ten TRI site. These sites are shown in **Figure M.8.**

FIGURE M.8: TOXIC RELEASE INVENTORY (TRI) SITES IN WAKE COUNTY



Source: EPA

In addition to "fixed" hazardous materials locations, hazardous materials may also impact the jurisdiction via roadways and rail. All roads that permit hazardous material transport are considered potentially at risk to an incident.

Historical Occurrences

The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) lists historical occurrences throughout the nation. A "serious incident" is a hazardous materials incident that involves:

- a fatality or major injury caused by the release of a hazardous material,
- the evacuation of 25 or more persons as a result of release of a hazardous material or exposure to fire,
- a release or exposure to fire which results in the closure of a major transportation artery,
- the alteration of an aircraft flight plan or operation,
- the release of radioactive materials from Type B packaging,
- the release of over 11.9 galls or 88.2 pounds of a severe marine pollutant, or
- the release of a bulk quantity (over 199 gallons or 882 pounds) of a hazardous material.

However, prior to 2002, a hazardous materials "serious incident" was defined as follows:

- a fatality or major injury due to a hazardous material,
- closure of a major transportation artery or facility or evacuation of six or more person due to the presence of hazardous material, or
- a vehicle accident or derailment resulting in the release of a hazardous material.

Table M.28 presents detailed information on historic HAZMAT incidents reported in Wake County.

TABLE M.28: SUMMARY OF HAZMAT INCIDENTS IN WAKE COUNTY

Report Number	Date	City	Mode	Serious Incident?	Fatalities/ Injuries	Damages ($)	Quantity Released
Wake County							
None reported							

Source: USDOT PHMSA

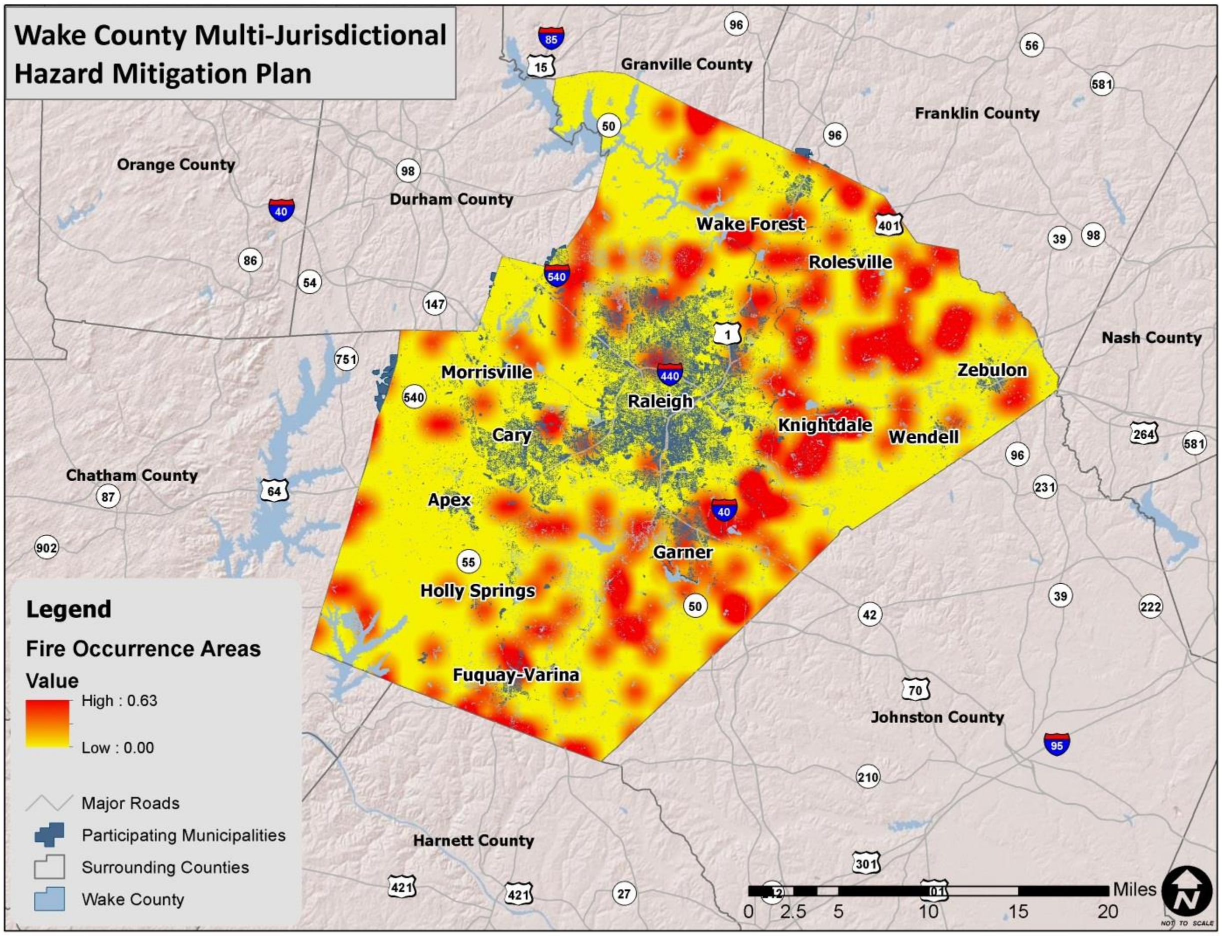
Probability of Future Occurrences
Given the location of ten toxic release inventory sites in Wake County and several roadways and rails that transport hazardous materials, it is possible that a hazardous material incident may occur in the jurisdiction (between 1 percent and 10 percent annual probability). Local officials are mindful of this possibility and take precautions to prevent such an event from occurring. Furthermore, there are detailed plans in place to respond to an occurrence.

M.2.15 Wildfire

Location and Spatial Extent
The entire jurisdiction is at some risk to a wildfire occurrence. However, several factors such as drought conditions or high levels of fuel on the forest floor, may make a wildfire more likely. Furthermore, areas in the urban-wildland interface are particularly susceptible to fire hazard as populations abut formerly undeveloped areas.

Historical Occurrences
Figure M.9 shows the Fire Occurrence Areas (FOA) in Wake County based on data from the Southern Wildfire Risk Assessment. This data is based on historical fire ignitions and is reported as the number of fires that occur per 1,000 acres each year. Therefore, even areas classified as at relatively high risk within the county are a relatively low risk compared to other areas of the state.

FIGURE M.9: HISTORIC WILDFIRE EVENTS IN WAKE COUNTY



Source: Southern Wildfire Risk Assessment

Based on data from the North Carolina Division of Forest Resources from 2003 to 2012, Wake County experiences an average of 16 wildfires annually which burn an average of 98 acres per year. The data indicates that most of these fires are small, averaging six acres per fire. **Table M.29** lists the number of reported wildfire occurrences in the county between the years 2003 and 2012.

TABLE M.29: HISTORICAL WILDFIRE OCCURRENCES IN WAKE COUNTY

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Wake County										
Number of Fires	8	13	18	23	28	12	2	21	17	13
Number of Acres	52.3	28.7	65.0	167.4	120.9	74.6	17.3	130.2	225.0	101.0

Source: North Carolina Division of Forest Resources

Probability of Future Occurrences

Wildfire events will be an ongoing occurrence in Wake County. The likelihood of wildfires increases during drought cycles and abnormally dry conditions. Fires are likely to stay small in size but could increase due local climate and ground conditions. Dry, windy conditions with an accumulation of forest floor fuel (potentially due to ice storms or lack of fire) could create conditions for a large fire that spreads quickly. It should also be noted that some areas do vary somewhat in risk. For example, highly developed areas are less susceptible unless they are located near the urban-wildland boundary. The risk will also vary due to assets. Areas in the urban-wildland interface will have much more property at risk, resulting in increased vulnerability and need to mitigate compared to rural, mainly forested areas. The probability assigned to Wake County for future wildfire events is possible (a 1 and 10 percent annual probability).

M.2.16 Nuclear Accident

Location and Spatial Extent

The entire county is at risk to a nuclear incident. However, areas in the southwest part of the region are more susceptible due to their proximity to the Shearon Harris Nuclear Station.

Historical Occurrences

Although there have been no major nuclear events at the Shearon Harris Nuclear Station, there is some possibility that one could occur as there have been incidents in the past in the United States at other facilities and at facilities around the world. In May of 2013, there was an unplanned shutdown of the plant which resulted from the discovery of a ¼ inch crack in the Reactor Pressure Vessel Head.

Shearon Harris has declared 2 “Alerts” and 28 “Notice of Unusual Events” since 1986, which are shown in **Table M.30**. There have also been 338 additional incidents reported to the NRC since 1986, but they did not necessitate an emergency declaration and therefore were not included in this analysis.

Table M.30: SHEARON HARRIS EMERGENCY DECLARATION HISTORY

Emergency Declaration	Date	Description
Alert	08/12/1988	Loss of greater than 50% of main control board (MCB) alarms due to electrical problems; normal power supply to annunciator panel failed and did not transfer to its backup inverter.
Alert	10/09/1988	Fire on “B” Main Electrical Transformer; release of flammable gas in the Protected Area.
Unusual Event	11/28/1986	Loss of ERFIS computer system to display Safety Parameter Display System (SPDS) (55 lapsed minutes).
Unusual Event	11/29/1986	Loss of ERFIS computer system to display SPDS (58 lapsed minutes).
Unusual Event	11/30/1986	Loss of ERFIS computer system to display SPDS (48 lapsed minutes).
Unusual Event	12/03/1986	Loss of ERFIS computer system to display SPDS (27 lapsed minutes).
Unusual Event	12/11/1986	Safety Injection (an Emergency Core Cooling System) actuated while testing electronic circuitry.
Unusual Event	01/27/1987	Loss of ERFIS computer system to display SPDS (23 lapsed minutes).
Unusual Event	07/11/1987	Loss of ERFIS computer system to display SPDS (22 lapsed minutes).
Unusual Event	07/24/1987	Loss of ERFIS computer system to display SPDS (32 lapsed minutes).
Unusual Event	07/25/1987	Loss of ERFIS computer system to display SPDS (28 lapsed minute).
Unusual Event	02/04/1988	Fire within the Protected Area greater than 10 minutes; smoke observed coming from the motor for the reactor auxiliary building supply fan.
Unusual Event	10/06/1988	RCS leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).
Unusual Event	10/20/1988	RCS leakage in excess of Tech Specs; pressure operated relief valve opened and admitted RCS inventory to the pressurized relief tank (PRT).
Unusual Event	11/17/1988	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	12/01/1988	Reactor coolant system (RCS) leakage in excess of Tech Specs (unidentified leakage > 1.0 gpm).

Emergency Declaration	Date	Description
Unusual Event	12/16/1988	High level alarm on radiological effluent release monitor the (Treated Laundry and Hot Shower high level alarm was set just above background).
Unusual Event	03/13/1989	Loss of ERFIS computer system to display SPDS for > 60 minutes.
Unusual Event	01/24/1991	Plant shutdown required by Technical Specifications. Excessive leakage of a containment penetration; leakage discovered during surveillance testing.
Unusual Event	02/15/1991	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	03/05/1991	Plant shutdown required by Technical Specifications (testing of "A" Reactor Coolant Pump (RCP) electrical protection function).
Unusual Event	04/14/1992	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/06/1993	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	02/17/1994	Loss of ERFIS computer system to display SPDS for > 4 hours.
Unusual Event	07/22/1994	Loss of both emergency diesel generators - "B" diesel generator was being worked on; in accordance with test procedures, "A" diesel generator is required to be tested within 24 hours following having redundant diesel out-of-service; did not pass test.
Unusual Event	11/05/1995	Unplanned emergency core cooling system (ECCS) discharge to the reactor vessel; reactor trip and safety injection (SI) occurred during the performance of testing.
Unusual Event	12/14/1995	Train derailment on site - while removing empty cask car from the Protected Area, the rail cars were moved onto the Engine Spur to allow passage of the CSX engine on adjacent Plant Spur; cask car shifted; 4 wheels of the car left the rails.
Unusual Event	01/22/1997	Security Event - while working Work Request and Authorization (WR&A), I&C Tech investigation found cut wire in a Turbine Building radiation monitor. Later determined to not be vandalism (i.e., not a security threat).
Unusual Event	04/02/2000	Loss of Emergency Response Facility Information System (ERFIS) computer system to display Safety Parameter Display System (SPDS) for more than 4 hours.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

The PULSTAR Nuclear Research Reactor has one reported "Notice of Unusual Events" since 1986, which is shown in **Table M.31**. This event occurred on August 23, 2011, and was due to seismic activity from the magnitude 5.8 earthquake near Mineral, Virginia. There were two additional known events in which an emergency declaration was not made and assistance was not required from the City of Raleigh or Wake County. One event occurred on July 2, 2011, and resulted in a shutdown of the reactor due to a 10-gallon-per-hour leak. The second event was reported on December 13, 2010, when a radiography technician walked in front of a 30 rem per hour beam of radiation for 60 seconds due to a shutter being left open.

Table M.31: PULSTAR Nuclear Research Reactor Incident History

Emergency Declaration	Date	Description
None	12/13/2010	A radiography technician walked in front of a 30 REM per hour beam of radiation for 60 seconds due to a shutter being left open. This incident was reported to the Nuclear Regulatory Commission (NRC), but no assistance was required from the City of Raleigh or Wake County.
None	07/02/2011	PULSTAR shut down due to a 10 gallon per hour leak. No emergency was declared (less than 350 gallons per hour reporting threshold), and no action was required from the City of Raleigh or Wake County.
Unusual Event	08/23/2011	Seismic activity at the site due to a magnitude 5.8 earthquake near Mineral, VA.

Probability of Future Occurrences

A major nuclear event is a very rare occurrence in the United States due to the intense regulation of the industry. There have been incidents in the past, but it is considered unlikely (less than 1 percent annual probability).

M.2.17 Terror Threat

Location and Spatial Extent

A terror threat could potentially occur at any location in the county. However, the very definition of a terrorist event indicates that it is most likely to be targeted at a critical or symbolic resource/location. Ensuring and protecting the continuity of critical infrastructure and key resources (CIKR) of the United States is essential to the Nation's security, public health and safety, economic vitality, and way of life. CIKR includes physical and/or virtual systems or assets that, if damaged, would have a detrimental impact on national security, including large-scale human casualties, property destruction, economic disruption, and significant damage to morale and public confidence. **Table M.32** shows the U.S. Department of Homeland Security's (DHS) identified main critical infrastructure sectors.

TABLE M.32 U.S. DEPARTMENT OF HOMELAND SECURITY CRITICAL INFRASTRUCTURE SECTORS

▪ Agriculture and Food	▪ Government Facilities
▪ Banking and Finance	▪ Healthcare and Public Health
▪ Chemical	▪ Information Technology
▪ Commercial Facilities	▪ National Monuments and Icons
▪ Communications	▪ Nuclear Reactors, Materials, and Waste
▪ Critical Manufacturing	▪ Postal and Shipping
▪ Dams	▪ Transportation Systems
▪ Defense Industrial Base	▪ Water
▪ Emergency Services	
▪ Energy	

Historical Occurrences

Although there have been no major terror events in Wake County, there is some possibility that one could occur as there have been incidents in the past in the United States and the county is a population center that is home to the capital of North Carolina and has potential targets.

Probability of Future Occurrences

Wake County has had no recorded terrorist events. Due to no recorded incidents against Wake County, the probability of future occurrences of a terrorist attack is rated as unlikely with less than 1 percent annual probability of an incident occurring.

M.2.18 Conclusions on Hazard Risk

The hazard profiles presented above were developed using best available data and result in what may be considered principally a qualitative assessment as recommended by FEMA in its "How-to" guidance document titled *Understanding Your Risks: Identifying Hazards and Estimating Losses* (FEMA Publication 386-2). It relies heavily on historical and anecdotal data, stakeholder input, and professional and

experienced judgment regarding observed and/or anticipated hazard impacts. It also carefully considers the findings in other relevant plans, studies, and technical reports.

Hazard Extent

Table M.33 describes the extent of each natural hazard identified for Wake County. The extent of a hazard is defined as its severity or magnitude, as it relates to the planning area.

TABLE M.33 EXTENT OF WAKE COUNTY HAZARDS

Atmospheric Hazards	
Drought	Drought extent is defined by the North Carolina Drought Monitor Classifications which include Abnormally Dry, Moderate Drought, Severe Drought, Extreme Drought, and Exceptional Drought (page M:4). According to the North Carolina Drought Monitor Classifications, the most severe drought condition is Exceptional. Wake County has received this ranking three times over the fourteen year reporting period.
Extreme Heat	The extent of extreme heat can be defined by the maximum temperature reached. The highest temperature recorded in Wake County is 107 degrees Fahrenheit in Raleigh in 1898.
Hailstorm	Hail extent can be defined by the size of the hail stone. The largest hail stone reported in Wake County was 3.00 inches. It should be noted that future events may exceed this.
Hurricane and Tropical Storm	Hurricane extent is defined by the Saffir-Simpson Scale which classifies hurricanes into Category 1 through Category 5 (Table 5.10). The highest magnitude hurricanes to traverse directly through Wake County were two storms which carried tropical force winds of 70 knots upon arrival in Wake County. Both an Unnamed Storm in 1893 and Hurricane Hazel in 1954 carried this maximum sustained wind speed. It should also be noted that Hurricane Fran, which struck more recently, attained maximum sustained winds of 57 knots.
Lightning	According to the NOAA flash density map (Figure 5.5), Wake County is located in an area that experiences 4 to 5 lightning flashes per square kilometer per year. It should be noted that future lightning occurrences may exceed these figures.
Thunderstorm Wind/High Wind	Thunderstorm extent is defined by the number of thunderstorm events and wind speeds reported. According to a 60-year history from the National Climatic Data Center, the strongest recorded wind event in Wake County was reported at 65 knots (approximately 75 mph). It should be noted that future events may exceed these historical occurrences.
Tornado	Tornado hazard extent is measured by tornado occurrences in the US provided by FEMA (Figure 5.6) as well as the Fujita/Enhanced Fujita Scale (Tables 5.18 and 5.19). The greatest magnitude reported was an F4 (reported on November 28, 1988).
Winter Storm and Freeze	The extent of winter storms can be measured by the amount of snowfall received (in inches). The greatest snowfall reported in Wake County was 20-24 inches during the Blizzard of 1996. Due to variations in storm systems, extent totals vary for each participating jurisdiction and reliable data on snowfall totals is not available.

Geologic Hazards	
Earthquake	Earthquake extent can be measured by the Richter Scale (Table 5.24) and the Modified Mercalli Intensity (MMI) scale (Table 5.25) and the distance of the epicenter from Wake County. According to data provided by the National Geophysical Data Center, the greatest MMI to impact the county was reported in Raleigh with a MMI of VIII (destructive) with a correlating Richter Scale measurement of approximately 7.2.
Landslide	As noted above in the landslide profile, the landslide data provided by the North Carolina Geological survey is incomplete. This provides a challenge when trying to determine an accurate extent for the landslide hazard. However, when using the USGS landslide susceptibility index, extent can be measured with incidence, which is between low and moderate in Wake County. There is also moderate susceptibility in some areas.
Hydrologic Hazards	
Dam Failure	Dam failure extent is defined using the North Carolina Division of Land Resources criteria (Table 5.30). Of the 5 dams in Wake County, 44 are classified as high-hazard.
Erosion	The extent of erosion can be defined by the measurable rate of erosion that occurs. There are no erosion rate records located in Wake County.
Flood	Flood extent can be measured by the amount of land and property in the floodplain as well as flood height and velocity. The amount of land in the floodplain accounts for 55 square miles of the total land area in Wake County. Flood depth and velocity are recorded via United States Geological Survey stream gages throughout the region. While a gage does not exist for each participating jurisdiction, there is one at or near many areas. The greatest peak discharge recorded for the area was at Crabtree Creek at Ebenezer Church Road (Raleigh) in 1973. Water reached a discharge of 117,007 cubic feet per second.
Other Hazards	
Hazardous Materials Incident	According to USDOT PHMSA, the largest hazardous materials incident reported in the county is 75 LGA released on the highway in Raleigh. It should be noted that larger events are possible.
Wildfire	Wildfire data was provided by the North Carolina Division of Forest Resources and is reported annually by county from 2003-2012. Analyzing the data indicates the following wildfire hazard extent. The greatest number of fires to occur in any year was 28 in 2007. The greatest number of acres to burn in a single year occurred in 2011 when 225 acres were burned. Although this data lists the extent that has occurred, larger and more frequent wildfires are possible throughout the region.
Nuclear Accident	Although there is not any historic precedent for a nuclear accident in Wake County, it is possible that a serious to major accident could occur. This would result in severe exposure to radiation for southwest Wake County (in the 10 mile buffer) and much of the rest of the county would also be impacted (50 mile buffer).

Terror Threat	There is no history of terror threats in Wake County however; it is possible that one of these events could occur. If this were to take place, the magnitude of the event could range on the scale of catastrophic with many fatalities and injuries to the population.

Priority Risk Index Results

In order to draw some meaningful planning conclusions on hazard risk for Wake County, the results of the hazard profiling process were used to generate countywide hazard classifications according to a "Priority Risk Index" (PRI). More information on the PRI and how it was calculated can be found in Section 5.20.2.

Table M.34 summarizes the degree of risk assigned to each category for all initially identified hazards based on the application of the PRI. Assigned risk levels were based on the detailed hazard profiles developed for this section, as well as input from the Regional Work Groups and Coordinating Committee. The results were then used in calculating PRI values and making final determinations for the risk assessment.

TABLE M.34: SUMMARY OF PRI RESULTS FOR WAKE COUNTY

Hazard	Category/Degree of Risk					
	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Score
Atmospheric Hazards						
Drought	Likely	Minor	Large	More than 24 hours	More than 1 week	**2.5**
Extreme Heat	Likely	Minor	Large	More than 24 hours	Less than 1 week	**2.4**
Hailstorm	Highly Likely	Minor	Moderate	6 to 12 hours	Less than 6 hours	**2.5**
Hurricane and Tropical Storm	Likely	Critical	Large	More than 24 hours	Less than 24 hours	**2.9**
Lightning	Highly Likely	Minor	Negligible	6 to 12 hours	Less than 6 hours	**2.1**
Thunderstorm/High Wind	Highly Likely	Critical	Moderate	6 to 12 hours	Less than 6 hours	**3.1**
Tornado	Likely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.7**
Winter Storm and Freeze	Likely	Limited	Moderate	More than 24 hours	Less than 1 week	**2.5**
Geologic Hazards						
Earthquake	Possible	Minor	Moderate	Less than 6 hours	Less than 6 hours	**2**
Landslide	Possible	Minor	Small	Less than 6 hours	Less than 6 hours	**1.8**
Hydrologic Hazards						
Dam and Levee Failure	Unlikely	Critical	Small	Less than 6 hours	Less than 6 hours	**2.1**
Erosion	Possible	Minor	Small	More than 24 hours	More than 1 week	**1.8**
Flood	Likely	Critical	Small	6 to 12 hours	Less than 1 week	**2.8**
Other Hazards						
Hazardous Materials Incident	Likely	Limited	Small	Less than 6 hours	Less than 24 hours	**2.5**
Wildfire	Possible	Minor	Small	Less than 6 hours	Less than 1 week	**2**
Nuclear Accident	Unlikely	Critical	Large	6 to 12 hours	Less than 1 week	**2.6**
Terror Threat	Unlikely	Critical	Moderate	Less than 6 hours	Less than 24 hours	**2.4**

M.2.16 Final Determinations on Hazard Risk

The conclusions drawn from the hazard profiling process for Wake County, including the PRI results and input from the Regional Work Groups and Coordinating Committee, resulted in the classification of risk for each identified hazard according to three categories: High Risk, Moderate Risk, and Low Risk (**Table M.35**). For purposes of these classifications, risk is expressed in relative terms according to the estimated impact that a hazard will have on human life and property throughout all of Wake County. A more quantitative analysis to estimate potential dollar losses for each hazard has been performed separately, and is described in Section 6: *Vulnerability Assessment* and below in Section M.3. It should be noted that although some hazards are classified below as posing low risk, their occurrence of varying or unprecedented magnitudes is still possible in some cases and their assigned classification will continue to be evaluated during future plan updates.

TABLE M.35: CONCLUSIONS ON HAZARD RISK FOR WAKE COUNTY

HIGH RISK	Severe Thunderstorm/High Wind Hurricane/Tropical Storm Tornado Flood
MODERATE RISK	Drought Extreme Heat Hailstorm Winter Storm and Freeze Hazardous Materials Incident Nuclear Accident Terror Threat
LOW RISK	Lightning Earthquake Landslide Dam and Levee Failure Erosion Wildfire

M.3 WAKE COUNTY VULNERABILITY ASSESSMENT

This subsection identifies and quantifies the vulnerability of Wake County to the significant hazards previously identified. This includes identifying and characterizing an inventory of assets in the county and assessing the potential impact and expected amount of damages caused to these assets by each identified hazard event. More information on the methodology and data sources used to conduct this assessment can be found in Section 6: *Vulnerability Assessment*.

M.3.1 Asset Inventory

Table M.36 lists the number of parcels, total value of parcels, total number of parcels with improvements, and the total assessed value of improvements for unincorporated Wake County (study area of vulnerability assessment).[17]

TABLE M.36: IMPROVED PROPERTY IN WAKE COUNTY

Location	Number of Parcels	Total Assessed Value of Parcels	Estimated Number of Buildings	Total Assessed Value of Improvements
Unincorporated Wake County	92,500	$36,869,910,205	88,745	$20,154,896,961

Table M.37 lists the fire stations, police stations, EMS stations, medical care facilities, schools, and other critical facilities located in unincorporated Wake County. These facilities were identified as primary critical facilities in that they are necessary to maintain government functions and protect the life, health, safety, and welfare of citizens. These primary facilities were geospatially mapped and used as the basis for further geographic analysis of the hazards that could potentially affect critical facilities.

All critical facility information was provided by local governments and their GIS departments. Much of the information for both the county and jurisdictions was provided by Wake County GIS. In addition, **Figure M.10** shows the locations of the primary critical facilities in Wake County. **Table M.48**, near the end of this section, shows a complete list of the critical facilities by name, as well as the hazards that affect each facility. As noted previously, this list is not all-inclusive and only includes information provided by the local government.

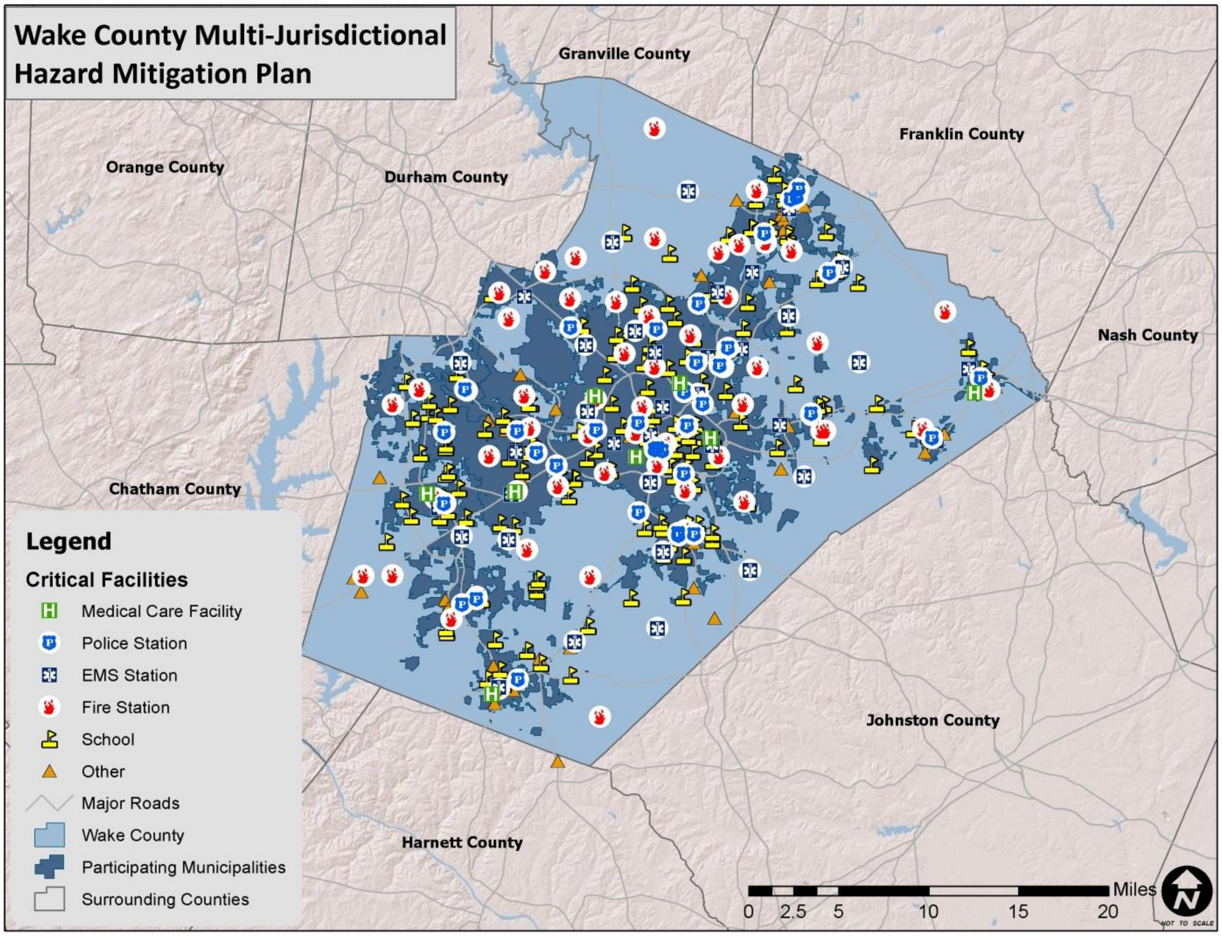
TABLE M.37: CRITICAL FACILITY INVENTORY IN WAKE COUNTY

Location	Fire Stations	Police Stations	EMS Stations	Medical Care Facilities	Schools	Other
Unincorporated Wake County	21	0	11	0	12	4

Source: Local Governments

[17] Total assessed values for improvements is based on tax assessor records as joined to digital parcel data. This data does not include dollar figures for tax-exempt improvements such as publicly-owned buildings and facilities. It should also be noted that, due to record keeping, some duplication is possible thus potentially resulting in an inflated value exposure for an area.

FIGURE M.10: CRITICAL FACILITY LOCATIONS IN WAKE COUNTY



Source: Local Governments

M.3.2 Social Vulnerability

In addition to identifying those assets potentially at risk to identified hazards, it is important to identify and assess those particular segments of the resident population in Wake County that are potentially at risk to these hazards.

Table M.38 lists the population by jurisdiction according to U.S. Census 2010 population estimates. Unfortunately, estimates were not available at the census block level, limited the results to county-wide estimates. The total population in unincorporated Wake County according to Census data is 181,890 persons. Additional population estimates are presented above in Section M.1.

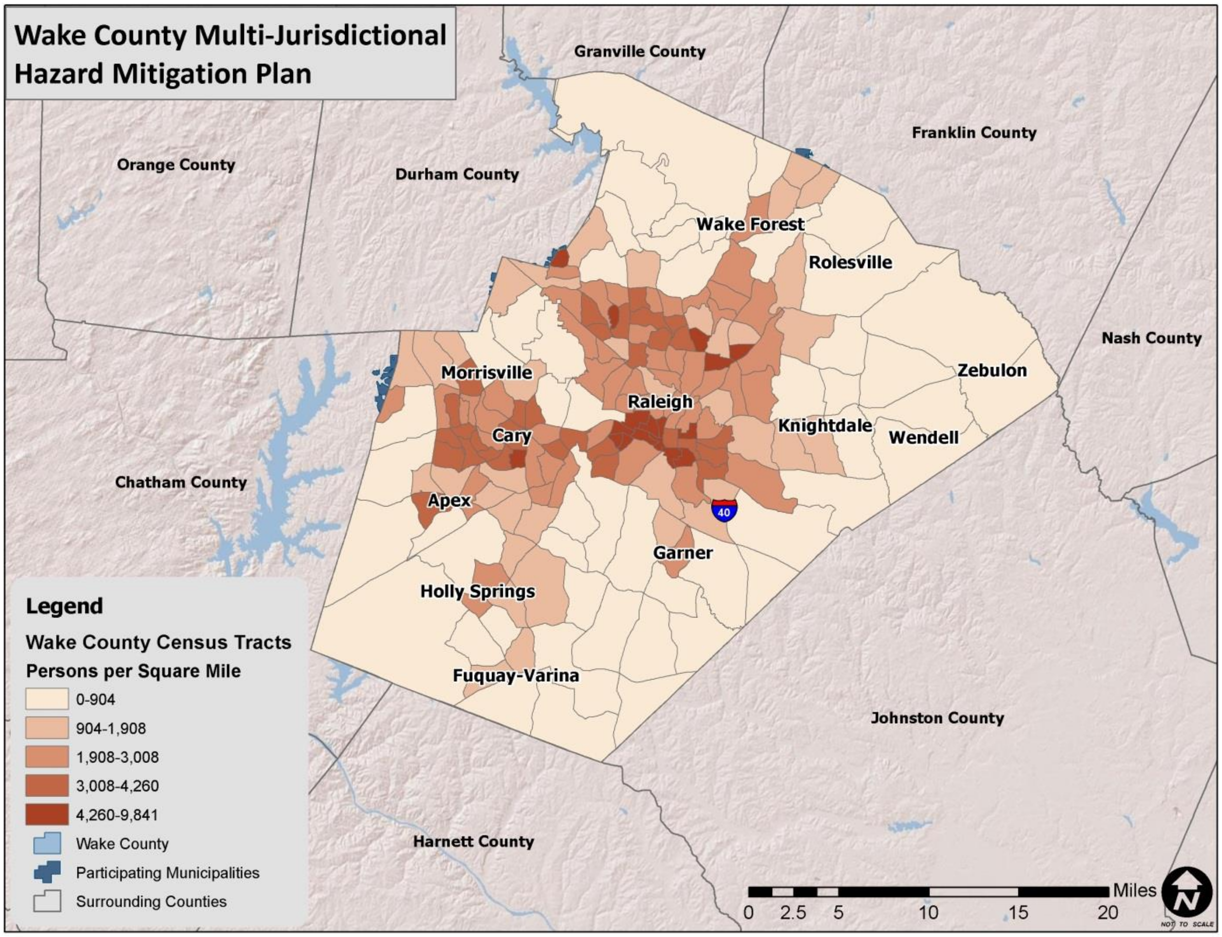
TABLE M.38: TOTAL POPULATION IN WAKE COUNTY

Location	Total 2010 Population
Unincorporated Wake County	181,890

Source: U.S. Census 2010

In addition, **Figure M.11** illustrates the population density by census tract as it was reported by the U.S. Census Bureau in 2010.[18]

FIGURE M.11: POPULATION DENSITY IN WAKE COUNTY



Source: U.S. Census Bureau, 2010

M.3.3 Vulnerability Assessment Results

As noted in Section 6: *Vulnerability Assessment*, only hazards with a specific geographic boundary, modeling tool, or sufficient historical data allow for further analysis. Those results, specific to Wake County, are presented here. All other hazards are assumed to impact the entire planning region (drought, extreme heat, hailstorm, lightning, thunderstorm/high wind, tornado, and winter storm and freeze) or, due to lack of data, analysis would not lead to credible results (erosion, dam and levee failure, terror threat). The total county exposure, and thus risk, was presented in **Table M.35**.

The annualized loss estimate for all hazards is presented at the end of this section in **Table M.47.**

The hazards presented in this section include: hurricane and tropical storm winds, earthquake, landslide, flood, hazardous materials incident, wildfire, and nuclear accident.

[18] Population by census block was not available at the time this plan was completed.

Hurricane and Tropical Storm

Historical evidence indicates that Wake County has a significant risk to the hurricane and tropical storm hazard. Several tracks have come near or traversed through the county, as shown and discussed in Section M.2.4.

Hurricanes and tropical storms can cause damage through numerous additional hazards such as flooding, erosion, tornadoes, and high winds and precipitation, thus it is difficult to estimate total potential losses from these cumulative effects. The current Hazus-MH hurricane model only analyzes hurricane winds and is not capable of modeling and estimating cumulative losses from all hazards associated with hurricanes; therefore only hurricane winds are analyzed in this section. It can be assumed that all existing and future buildings and populations are at risk to the hurricane and tropical storm hazard. Hazus-MH 2.1 was used to determine annualized losses for the county as shown below in **Table M.39.** Only losses to buildings are reported, in order to best match annualized losses reported for other hazards. Hazus-MH reports losses at the U.S. Census tract level, so determining participating jurisdiction losses was not possible.

TABLE M.39: ANNUALIZED LOSS ESTIMATIONS FOR HURRICANE WIND HAZARD

Location	Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$9,936,000**	**$3,892,000**	**$28,000**	**$13,856,000**

Source: Hazus-MH 2.1

In addition, probable peak wind speeds were calculated in Hazus. These are shown below in **Table M.40.**

TABLE M.40: PROBABLE PEAK HURRICANE/TROPICAL STORM WIND SPEEDS (MPH)

Location	50-year event	100-year event	500-year event	1,000-year event
Wake County	76.6	85.7	104.6	111.2

Source: Hazus-MH 2.1

Social Vulnerability

Given equal susceptibility across the county, it is assumed that the total population is at risk to the hurricane and tropical storm hazard.

Critical Facilities

Given equal vulnerability across Wake County, all critical facilities are considered to be at risk. Some buildings may perform better than others in the face of such an event due to construction and age, among other factors. Determining individual building response is beyond the scope of this plan. However, this plan will consider mitigation actions for vulnerable structures, including critical facilities, to reduce the impacts of the hurricane wind hazard. A list of specific critical facilities and their associated risk can be found in **Table M.48** at the end of this section.

In conclusion, a hurricane event has the potential to impact many existing and future buildings, critical facilities, and populations in Wake County. Hurricane events can cause substantial damage in their wake including fatalities, extensive debris clean-up, and extended power outages.

Earthquake

For the earthquake hazard vulnerability assessment, a probabilistic scenario was created to estimate the annualized loss for the county. The results of the analysis reported at the U.S. Census tract level do not make it feasible to estimate losses at the jurisdiction level. Since the scenario is annualized, no building counts are provided. Losses reported included losses due to building damage (structural and non-structural), contents, and inventory. However, like the analysis for hurricanes, the comparative annualized loss figures at the end of this chapter only utilize building losses in order to provide consistency with other hazards. **Table M.41** summarizes the findings.

TABLE M.41: ANNUALIZED LOSS ESTIMATIONS FOR EARTHQUAKE HAZARD

Location	Structural Building Loss	Non Structural Building Loss	Contents Loss	Inventory Loss	Total Annualized Loss
Wake County	**$119,000**	**$314,000**	**$88,000**	**$3,000**	**$524,000**

Source: Hazus-MH 2.1

Social Vulnerability

It can be assumed that all existing future populations are at risk to the earthquake hazard.

Critical Facilities

The Hazus probabilistic analysis indicated that no critical facilities would sustain measurable damage in an earthquake event. However, all critical facilities should be considered at-risk to minor damage, should an event occur. A list of individual critical facilities and their risk can be found in **Table M.48**.

In conclusion, an earthquake has the potential to impact all existing and future buildings, facilities, and populations in Wake County. Minor earthquakes may rattle dishes and cause minimal damage while stronger earthquakes will result in structural damage as indicated in the Hazus scenario above. Impacts of earthquakes include debris clean-up, service disruption and, in severe cases, fatalities due to building collapse. Specific vulnerabilities for assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available. Furthermore, mitigation actions to address earthquake vulnerability will be considered.

Landslide

In order to complete the vulnerability assessment for landslides in Wake County, GIS analysis was used. The potential dollar value of exposed land and property total can be determined using the USGS Landslide Susceptibility Index (detailed in Section M.2.10), tax parcel and building footprint data, and GIS analysis. **Table M.42** presents the potential at-risk property where available. All areas of Wake County are identified as low or moderate incidence areas by the USGS landslide data. Some areas are also of moderate landslide susceptibility. Since there were no high incidence levels in the county, the moderate incidence level was used to identify different areas of concern for the analysis below.

TABLE M. 42: TOTAL POTENTIAL AT-RISK PARCELS FOR THE LANDSLIDE HAZARD

Location	Number of Parcels At Risk	Number of Improvements At Risk	Total Value of Improvements At Risk ($)
Incidence Level	**Moderate**		
Unincorporated Wake County	6,673	5,396	$3,145,211,453

Source: USGS

Social Vulnerability
Given low susceptibility across most of Wake County, it is assumed that much of the total population is at a very low risk to landslides. However, Wake County is probably at somewhat higher risk than other jurisdictions.

Critical Facilities
Six critical facilities are located in a moderate susceptibility area. This includes 1 EMS station, 4 fire stations, and 1 other. A list of specific critical facilities and their associated risk can be found in **Table M.48** at the end of this section.

In conclusion, a landslide has the potential to impact existing and future buildings, facilities, and populations in Wake County, though some areas are at a higher risk than others due to a variety of factors. For example, steep slopes and modified slopes bear a greater risk than flat areas. Specific vulnerabilities for county assets will be greatly dependent on their individual design and the mitigation measures in place, where appropriate. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates if data becomes available.

Flood
Historical evidence indicates that Wake County is susceptible to flood events. A total of 46 flood events have been reported by the National Climatic Data Center resulting in $220,101 in damages. On an annualized level, these damages amounted to $12,228 for Wake County.

In order to assess flood risk, a GIS-based analysis was used to estimate exposure to flood events using Digital Flood Insurance Rate Map (DFIRM) data in combination with local tax assessor records for the county. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within an identified floodplain. **Table M.43** presents the potential at-risk property. Both the number of parcels and the approximate value are presented.

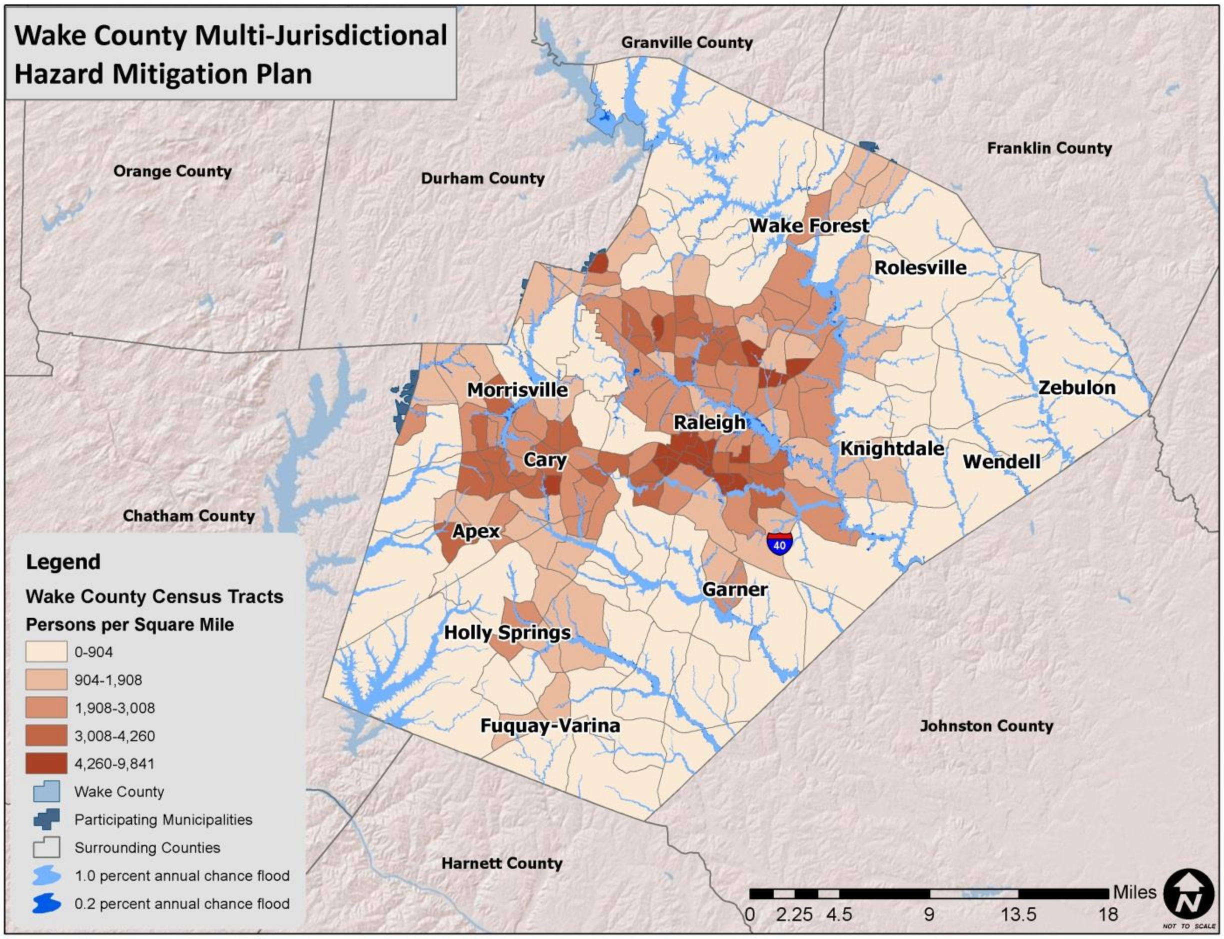
TABLE M.43: ESTIMATED EXPOSURE OF PARCELS TO THE FLOOD HAZARD

Location	1.0-percent ACF			0.2-percent ACF		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings
Unincorporated Wake County	6,093	373	$2,834,713,327	467	192	$237,670,063

Source: FEMA DFIRM

Social Vulnerability
Since 2010 population was available at the tract level, it was difficult to determine a reliable figure on population at-risk to flood due to tract level population data. **Figure M.12** is presented to gain a better understanding of at risk population.

FIGURE M.12 : POPULATION DENSITY NEAR FLOODPLAINS



Source: FEMA DFIRM, U.S. Census 2010

Critical Facilities

The critical facility analysis revealed that there are a no critical facilities located in the Wake County 1.0-percent annual chance floodplain and 0.2-percent annual chance floodplain based on FEMA DFIRM boundaries and GIS analysis. A list of specific critical facilities and their associated risk can be found in **Table M.48** at the end of this section.

In conclusion, a flood has the potential to impact many existing and future buildings and populations in Wake County, though some areas are at a higher risk than others. All types of structures in a floodplain are at-risk, though elevated structures will have a reduced risk. As noted, the floodplains used in this analysis include the 100-year and 500-year FEMA regulated floodplain boundaries. It is certainly possible that more severe events could occur beyond these boundaries or urban (flash) flooding could impact additional structures. Such site-specific vulnerability determinations are outside the scope of this assessment but will be considered during future plan updates. Furthermore, areas subject to repetitive flooding should be analyzed for potential mitigation actions.

Hazardous Materials Incident

Although historical evidence and existing Toxic Release Inventory sites indicate that Wake County is susceptible to hazardous materials events, there are few reports of damage. Therefore, it is difficult to calculate a reliable annualized loss figure. It is assumed that while one major event could result in significant losses, annualizing structural losses over a long period of time would most likely yield a negligible annualized loss estimate for Wake County.

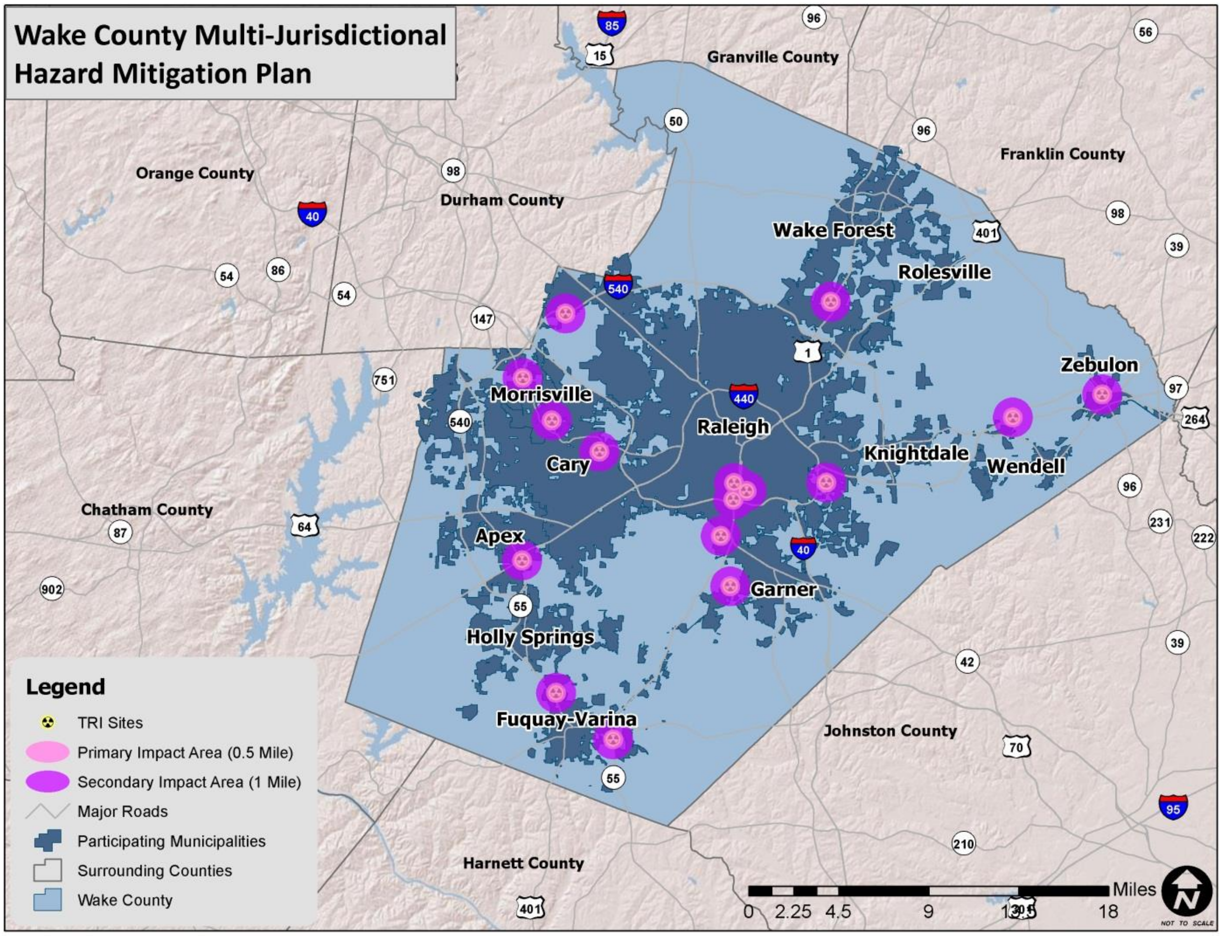
One significant hazardous materials event to impact Wake County occurred on October 2, 2006 when the EQ Industrial Services (a hazardous waste handling company) exploded. The event displaced 17,000 citizens and lasted for three days.

Most hazardous materials incidents that occur are contained and suppressed before destroying any property or threatening lives. However, they can have a significant negative impact. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid, and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions will directly affect how the hazard develops. Certain chemicals may travel through the air or water, affecting a much larger area than the point of the incidence itself. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment features, can substantially increase the damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

In order to conduct the vulnerability assessment for this hazard, GIS intersection analysis was used for fixed and mobile areas and parcels.[19] In both scenarios, two sizes of buffers—0.5-mile and 1.0-mile—were used. These areas are assumed to respect the different levels of effect: immediate (primary) and secondary. Primary and secondary impact sites were selected based on guidance from the PHMSA Emergency Response Guidebook. For the fixed site analysis, geo-referenced TRI listed toxic sites in Wake County, along with buffers, were used for analysis as shown in **Figure M.13.** For the mobile analysis, the major roads (Interstate highway, U.S. highway, and State highway) and railroads, where hazardous materials are primarily transported that could adversely impact people and buildings, were used for the GIS buffer analysis. **Figure M.14** shows the areas used for mobile toxic release buffer analysis. The results indicate the approximate number of parcels, improved value, as shown in **Table M.44** (fixed sites), **Table M.45** (mobile road sites) and **Table M.46** (mobile railroad sites).[20]

[19] This type of analysis will likely yield inflated results (generally higher than what is actually reported after an event).
[20] Note that parcels included in the 1.0-mile analysis are also included in the 0.5-mile analysis.

FIGURE M.13 : TRI SITES WITH BUFFERS IN WAKE COUNTY



Source: EPA

TABLE M.44: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS (FIXED SITES)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Unincorporated Wake County	750	452	$884,583,035	3,345	2,599	$1,474,039,219

FIGURE M.14 : MOBILE HAZMAT BUFFERS IN WAKE COUNTY

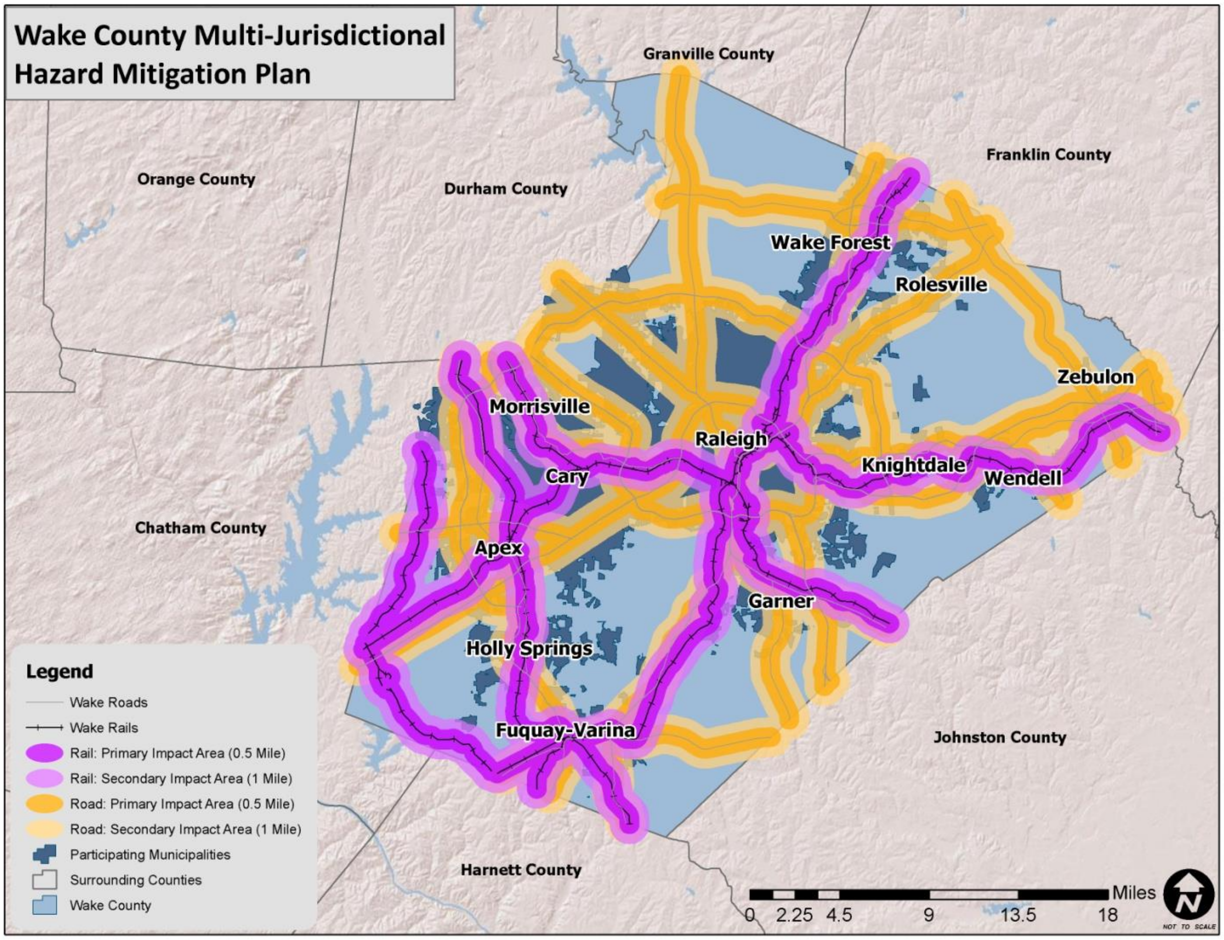


TABLE M.45: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - ROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Unincorporated Wake County	29,836	26,417	$8,095,982,143	51,171	47,032	$12,306,306,740

TABLE M.46: EXPOSURE OF IMPROVED PROPERTY TO HAZARDOUS MATERIALS SPILL (MOBILE ANALYSIS - RAILROAD)

Location	0.5-mile buffer			1.0-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value	Approx. Number of Parcels	Approx. Number Improved	Approx. Improved Value
Unincorporated Wake County	11,758	10,547	$2,979,477,839	21,718	20,060	$5,352,080,287

Social Vulnerability
Given high susceptibility across the jurisdiction, it is assumed that the total population is at risk to a hazardous materials incident. It should be noted that areas of population concentration may be at an elevated risk due to a greater burden to evacuate population quickly.

Critical Facilities
Fixed Site Analysis:
The critical facility analysis for fixed TRI sites revealed that 1 critical facility is located in a HAZMAT risk zone. The primary impact zone does not include any facilities. A list of specific critical facilities and their associated risk can be found in **Table M.48** at the end of this section.

Mobile Analysis:
The critical facility analysis for road transportation corridors in Wake County revealed that there are 31 critical facilities are located in a HAZMAT risk zone. The primary impact zone includes 23 facilities. The remaining facilities are in the secondary, 1.0-mile zone. The railroad buffer areas include 10 facilities with 5 in the primary impact zone. It should be noted that many of the facilities located in the buffer areas for railroad are also located in the buffer areas for road and/or the fixed site analysis. A list of specific critical facilities and their associated risk can be found in **Table M.48** at the end of this section.

In conclusion, a hazardous material incident has the potential to impact many existing and future buildings, critical facilities, and populations in Wake County. Those areas in a primary buffer are at the highest risk, though all areas carry some vulnerability due to variations in conditions that could alter the impact area such direction and speed of wind, volume of release, etc. Further, incidents from neighboring jurisdictions could also have an impact.

Wildfire
Although historical evidence indicates that Wake County is susceptible to wildfire events, there are few reports of damage. Upon conversion of the wildfire risk data (see Section 6: *Vulnerability Assessment*) and completion of the wildfire analysis, it was determined that less than 4,000 square feet in the entire county registered at over 1 on the Level of Concern scale for wildfire. This indicates that the relative risk of wildfire is extremely low compared to other counties in the state, which resulted in zero or near zero counts of buildings and facilities located in the wildfire risk zones. Therefore, no tables or figures are included and the overall risk for the jurisdiction should be assumed to be very low. As such, it is difficult to calculate a reliable annualized loss figure. Annualized loss is considered negligible though it should be noted that a single event could result in significant damages throughout the county.

Social Vulnerability
All areas have relatively equal vulnerability and there is low susceptibility across the entire county.
It is assumed that the total population is at low risk to the wildfire hazard.

Critical Facilities
The critical facility analysis revealed that there are no critical facilities located in wildfire areas of concern. It should be noted, however, that several factors could impact the spread of a wildfire putting all facilities at risk. A list of specific critical facilities and their associated risk can be found in **Table M.48** at the end of this section.

In conclusion, a wildfire event has the potential to impact some existing and future buildings, critical facilities, and populations in Wake County.

Nuclear Accident

The location of Shearon Harris Nuclear Station in southwest Wake County demonstrates that the county is at risk to the effects of a nuclear accident. Although there have not been any major events at this plant in the past, there have been major events at other nuclear stations around the country. Additionally, smaller scale incidents at Shearon-Harris Nuclear Station have occurred.

In order to assess nuclear risk, a GIS-based analysis was used to estimate exposure during a nuclear event within each of the risk zones described in *Section 5: Hazard Profiles*. The determination of assessed value at-risk (exposure) was calculated using GIS analysis by summing the total assessed building values for only those improved properties that were confirmed to be located within one of the risk zones. All areas of Wake County are located within one of the risk zones. **Table M.47** present the potential at-risk property. Both the number of parcels/buildings and the approximate value are presented.

TABLE A.47: ESTIMATED EXPOSURE OF PARCELS/BUILDINGS TO A NUCLEAR ACCIDENT

Location	10-mile buffer			50-mile buffer		
	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[21]	Approx. Number of Parcels	Approx. Number Improved Buildings	Approx. Improved Value of Buildings[22]
Unincorporated Wake County	10,274	8,993	$2,050,839,254	92,500	88,745	$20,154,896,961

Social Vulnerability

Since all areas of the county are within at least the 50-mile buffer area, the total population is considered to be at risk to a nuclear accident. However, populations in the southwest part of the county are considered to be at an elevated risk.

Critical Facilities

The critical facility analysis revealed that there are a total of six critical facilities located in the 10-mile nuclear buffer area including 1 EMS stations, 4 fire stations, and 1 other in Wake County.

In conclusion, a nuclear accident has the potential to impact many existing and future buildings, facilities, and populations in Wake County, though areas closer to the power plant are at a higher risk than others. All structures are at some risk given that they are all located within at least the 50-mile buffer area.

Conclusions on Hazard Vulnerability

Table M.48 presents a summary of annualized loss for each hazard in Wake County. Due to the reporting of hazard damages primarily at the county level, it was difficult to determine an accurate annualized loss estimate for each municipality. Therefore, although an annualized loss was determined

[21] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 10-mile buffer, since building footprints were not associated with dollar value data.

[22] Improved value of buildings is estimated based on the building value associated with parcels that have been identified as being located in the 50-mile buffer, since building footprints were not associated with dollar value data.

through the damage reported through historical occurrences at the municipal level, it is likely that the county-wide estimate (found in Section 6: *Vulnerability Assessment*) is potentially a better estimate. These values should be used as an additional planning tool or measure risk for determining hazard mitigation strategies.

TABLE M.48: ANNUALIZED LOSS FOR WAKE COUNTY*

Event	Wake County
Dam Failure	Negligible
Drought	Negligible
Erosion	Negligible
Extreme Heat	Negligible
Hail	Negligible
Hurricane & Tropical Storm	Negligible
Landslide	Negligible
Lightning	$21,029
Thunderstorm Wind/High Wind[23]	$5,875
Tornado	$11,111,453
Winter Storm & Freeze	$47,408
Flood	$12,228
Earthquake	Negligible
HAZMAT Incident	Negligible
Wildfire	Negligible
Nuclear Accident	Negligible
Terror Threat	Negligible

*In this table, the term "Negligible" is used to indicate that no records for the particular hazard were recorded. This could be the case either because there were no events that caused dollar damage or because documentation of that particular type of event is not kept.

As noted previously, all existing and future buildings and populations (including critical facilities) are vulnerable to atmospheric hazards including drought, hailstorm, hurricane and tropical storm, lightning, thunderstorm wind, tornado, and winter storm and freeze. Some buildings may be more vulnerable to these hazards based on locations, construction, and building type. **Table M.49** shows the critical facilities vulnerable to additional hazards analyzed in this section. The table lists those assets that are determined to be exposed to each of the identified hazards (marked with an "**X**").

[23] The annualized losses for these hazards were combined.

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TABLE M.49: AT-RISK CRITICAL FACILITIES IN WAKE COUNTY

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
WAKE COUNTY																								
HOLLY SPRINGS	EMS STATION	X	X	X	X	X	X	X	X	X								X		X		X	X	X
WAKE CROSSROADS	EMS STATION	X	X	X	X	X	X	X	X	X						X	X	X					X	X
STONY HILL	EMS STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
HILLTOP	EMS STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
BETHANY CHURCH	EMS STATION	X	X	X	X	X	X	X	X	X													X	X
SIX FORKS NORTH	EMS STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
RDU AIRPORT	EMS STATION	X	X	X	X	X	X	X	X	X		X					X	X					X	X
GARNER SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X													X	X
KNIGHTDALE SOUTH	EMS STATION	X	X	X	X	X	X	X	X	X								X					X	X
KNIGHTDALE WEST	EMS STATION	X	X	X	X	X	X	X	X	X							X	X		X			X	X
MINICITY	EMS STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
APEX #2	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X	X	X		X	X	X
FUQUAY-VARINA #2	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
GARNER #2	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
FAIRVIEW #2	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
FAIRVIEW #1	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
RDU CFR	FIRE STATION	X	X	X	X	X	X	X	X	X		X											X	X
EASTERN WAKE #1	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
HOPKINS	FIRE STATION	X	X	X	X	X	X	X	X	X								X					X	X
WENDELL #2	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
WAKE-NEW HOPE #2	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
FALLS	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
BAY LEAF #1	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
STONY HILL #1	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
STONY HILL #2	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
BAY LEAF #2	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X					X	X
DURHAM HIGHWAY #1	FIRE STATION	X	X	X	X	X	X	X	X	X													X	X
FUQUAY-VARINA #3	FIRE	X	X	X	X	X	X	X	X	X													X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
	STATION																							
HOLLY SPRINGS #1	FIRE STATION	X	X	X	X	X	X	X	X	X								X		X		X	X	X
HOLLY SPRINGS #2	FIRE STATION	X	X	X	X	X	X	X	X	X							X	X	X	X		X	X	X
HOLLY SPRINGS #3	FIRE STATION	X	X	X	X	X	X	X	X	X		X					X	X				X	X	X
RFD #29	FIRE STATION	X	X	X	X	X	X	X	X	X		X						X					X	X
JAMES REST HOME	OTHER	X	X	X	X	X	X	X	X	X		X					X	X				X	X	X
SPRING ARBOR ADULT CARE OF EAST RALEIGH	OTHER	X	X	X	X	X	X	X	X	X							X	X					X	X
WALTONWOOD CARY PARKWAY ADULT CARE	OTHER	X	X	X	X	X	X	X	X	X							X	X					X	X
HOSPICE OF WAKE COUNTY	OTHER	X	X	X	X	X	X	X	X	X							X	X					X	X
SWIFT CREEK ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
BRASSFIELD ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
PLEASANT UNION ES	SCHOOL	X	X	X	X	X	X	X	X	X								X					X	X
EAST WAKE HS	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
CARVER ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X	X	X			X	X
YATES MILL ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
JONES DAIRY ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X
EAST WAKE SCHOOL OF HEALTH SCIENCE	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
SMITH ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X		X			X	X

		ATMOSPHERIC								GEOLOGIC			HYDROLOGIC		OTHER									
FACILITY NAME	FACILITY TYPE	Drought	Extreme Heat	Hailstorm	Hurricane and Tropical Storm	Lightning	Thunderstorm	Tornado	Winter Storm and Freeze	Earthquake	Landslide – High Incidence	Landslide- Mod. Incidence	Flood – 100 yr	Flood – 500 yr	Fixed HAZMAT 0.5 mile	Fixed HAZMAT 1.0 mile	Mobile HZMT 0.5 mile (road)	Mobile HZMT 1.0 mile (road)	Mobile HZMT 0.5 mile (rail)	Mobile HZMT 1.0 mile (rail)	Wildfire	Nuclear Accident 10 mile	Nuclear Accident 50 mile	Terror Threat
EAST WAKE SCHOOL OF INTEGRATED TECHNOLOGY	SCHOOL	X	X	X	X	X	X	X	X	X							X	X					X	X
FRED A. SMITH ES	SCHOOL	X	X	X	X	X	X	X	X	X							X	X		X			X	X
VANCE ES	SCHOOL	X	X	X	X	X	X	X	X	X													X	X

M.4 WAKE COUNTY CAPABILITY ASSESSMENT

This subsection discusses the capability of the Wake County to implement hazard mitigation activities. More information on the purpose and methodology used to conduct the assessment can be found in Section 7: *Capability Assessment*.

M.4.1 Planning and Regulatory Capability

Table M.50 provides a summary of the relevant local plans, ordinances, and programs already in place or under development for the Wake County. A checkmark (✓) indicates that the given item is currently in place and being implemented. An asterisk (*) indicates that the given item is currently being developed for future implementation. Each of these local plans, ordinances, and programs should be considered available mechanisms for incorporating the requirements of the Wake County Hazard Mitigation Plan.

TABLE M.50: RELEVANT PLANS, ORDINANCES, AND PROGRAMS

Planning Tool/Regulatory Tool	Hazard Mitigation Plan	Comprehensive Land Use Plan	Floodplain Management Plan	Open Space Management Plan (Parks & Rec/Greenway Plan	Stormwater Management Plan/Ordinance	Natural Resource Protection Plan	Flood Response Plan	Emergency Operations Plan	Continuity of Operations Plan	Evacuation Plan	Disaster Recovery Plan	Capital Improvements Plan	Economic Development Plan	Historic Preservation Plan	Flood Damage Prevention Ordinance	Zoning Ordinance	Subdivision Ordinance	Unified Development Ordinance	Post-Disaster Redevelopment Ordinance	Building Code	Fire Code	National Flood Insurance Program (NFIP)	NFIP Community Rating System
Wake County	✓	✓	✓	✓	✓		✓	✓	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	

A more detailed discussion on the county's planning and regulatory capabilities follows.

Emergency Management

Hazard Mitigation Plan
Wake County has previously adopted a hazard mitigation plan.

Emergency Operations Plan
Wake County has adopted the Wake County Emergency Operations Plan. The county also maintains a municipal-level emergency operations plan.

General Planning

Comprehensive Land Use Plan
Wake County has adopted a Land Use Plan as well as a growth management plan.

Capital Improvements Plan
Wake County has a long-range capital improvement program plan in place.

Zoning Ordinance
Wake County includes zoning regulations as part of the local unified development ordinance.

Subdivision Ordinance
Wake County also includes subdivision regulations as part of the local unified development ordinance.

Building Codes, Permitting, and Inspections
North Carolina has a state compulsory building code which applies throughout the state. The building code is enforced within the county's planning jurisdiction by the Wake County Building Inspections and Permits Department.

Floodplain Management

Table M.51 provides NFIP policy and claim information for the Wake County.

TABLE M.51: NFIP POLICY AND CLAIM INFORMATION

Jurisdiction	Date Joined NFIP	Current Effective Map Date	NFIP Policies in Force	Insurance in Force	Closed Claims	Total Payments to Date
Wake County	11/15/78	04/16/13	405	$108,769,300	62	$787,324

Source: NFIP Community Status information as of 3/20/14; NFIP claims and policy information as of 12/31/13

Flood Damage Prevention Ordinance
All communities participating in the NFIP are required to adopt a local flood damage prevention ordinance. Wake County participates in the NFIP and has adopted flood damage prevention regulations.

Open Space Management Plan
Wake County has adopted an open space master plan that is administered by Parks and Recreation.

Stormwater Management Plan
Wake County has not adopted a stormwater management plan; however, the county includes stormwater management regulations as part of the local unified development ordinance.

M.4.2 Administrative and Technical Capability

Table M.52 provides a summary of the capability assessment results for Wake County with regard to relevant staff and personnel resources. A checkmark (✓) indicates the presence of a staff member(s) in the county with the specified knowledge or skill.

TABLE M.52: RELEVANT STAFF / PERSONNEL RESOURCES

Staff / Personnel Resource	Planners with knowledge of land development/land management practices	Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Planners or engineers with an understanding of natural and/or human-caused hazards	Emergency Manager	Floodplain Manager	Land Surveyors	Scientists familiar with the hazards of the community	Staff with education or expertise to assess the community's vulnerability to hazards	Personnel skilled in GIS and/or Hazus	Resource development staff or grant writers
Wake County	✓	✓	✓	✓	✓		✓	✓	✓	✓

Credit for having a floodplain manager was given to those jurisdictions that have a flood damage prevention ordinance, and therefore an appointed floodplain administrator, regardless of whether the appointee was dedicated solely to floodplain management. Credit was given for having a scientist familiar with the hazards of the community if a jurisdiction has a Cooperative Extension Service or Soil and Water Conservation Department. Credit was also given for having staff with education or expertise to assess the community's vulnerability to hazards if a staff member from the jurisdiction was a participant on the existing hazard mitigation plan's planning committee.

M.4.3 Fiscal Capability

Table M.53 provides a summary of the results for Wake County with regard to relevant fiscal resources. A checkmark (✓) indicates that the given fiscal resource is locally available for hazard mitigation purposes (including match funds for state and federal mitigation grant funds) according to the previous hazard mitigation plan.

TABLE M.53: RELEVANT FISCAL RESOURCES

Fiscal Tool / Resource	Capital Improvement Programming	Community Development Block Grants (CDBG)	Special Purpose Taxes (or taxing districts)	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other: PDM, FMAP, HMGP, PA, other Federal and state funding sources, etc.
Wake County	✓	✓	✓	✓	✓		✓	✓	✓	✓

M.4.4 Political Capability

The previous hazard mitigation plan indicates that the citizens, property owners, business owners, and elected officials of Wake County are committed to improving the community through hazard mitigation. The County Manager along with the Board of Commissioners continually strive to make Wake County a safer community in which to live and work. These officials see the hazard mitigation plan as a key component in helping to achieve that goal.

M.4.5 Conclusions on Local Capability

Table M.54 shows the results of the capability assessment using the designed scoring methodology described in Section 7: *Capability Assessment*. The capability score is based solely on the information found in the existing hazard mitigation plan and readily available on the county's government website. According to the assessment, the local capability score for the county is 49, which falls into the high capability ranking.

TABLE M.54: CAPABILITY ASSESSMENT RESULTS

Jurisdiction	Overall Capability Score	Overall Capability Rating
Wake County	49	High

M.5 WAKE COUNTY MITIGATION STRATEGY

This subsection provides the blueprint for Wake County to follow in order to become less vulnerable to its identified hazards. It is based on general consensus of the Regional Work Groups and the findings and conclusions of the capability assessment and risk assessment. Additional Information can be found in Section 8: *Mitigation Strategy* and Section 9: *Mitigation Action Plan*.

M.5.1 Mitigation Goals

Wake County developed seven mitigation goals in coordination with other participating jurisdictions. The county-wide mitigation goals are presented in **Table M.55**.

TABLE M.55: WAKE COUNTY MITIGATION GOALS

	Goal
Goal #1	Protect public health, life, safety, and welfare by increasing public awareness and education of hazards and by encouraging collective and individual responsibility for mitigating hazard risks.
Goal #2	Improve technical capability to respond to hazards and to improve the effectiveness of hazard mitigation actions
Goal #3	Enhance existing or create new policies and ordinances that will help reduce the damaging effects of natural hazards.
Goal #4	Minimize threats to life and property by protecting the most vulnerable populations, buildings, and critical facilities through the implementation of cost-effective and technically feasible mitigation actions.
Goal #5	Generally reduce the impact of all natural hazards
Goal #6	Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
Goal #7	Ensure that disaster response and recovery personnel have the necessary equipment and supplies available in order to serve the public in the event of a disaster

M.5.2 Mitigation Action Plan

The mitigation actions proposed by Wake County are listed in the following Mitigation Action Plan.

Wake County Mitigation Action Plan

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
Prevention							
P-1	Continue to prohibit the placement of any new residential or commercial structures or the introduction of fill in the floodway or floodway fringe.	Flood	High	Wake Planning and Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-2	Initiate hydrologic and hydraulic modeling of the stormwater system to provide a representation of watersheds and predict the water quantity response of streams and rivers to land use conditions and storm events.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-3	Apply 100-foot buffers to perennial streams in water supply watersheds, and study the possibility of increasing the protection of other watercourses and drainageways in Wake County.	Flood	Moderate	Wake Planning and Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-4	Apply 100-foot wide undisturbed stream buffers to the lower Swift Creek and study it for Little River watershed.	Flood	Moderate	Wake Planning and Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-5	Study the possibility of establishing either a stormwater utility or some other permanent dedicated funding source for stormwater and floodplain programs.	Flood, Drought, Riverine Erosion	High	N/A	Local	Deleted	Stormwater Management Task Force did not recommend this action. Board of Commissioners agreed.
P-6	Initiate NPDES Phase II Stormwater Program as required.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Deleted	Wake County does not have an MS4 System therefore a permit is not required.
P-7	Collaborate on NPDES Phase II minimum measures where local governments on a voluntary basis can request that Wake County provide staff and resources related to any and all functions required by Phase II stormwater rules.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-8	Create development regulations to encourage use of low impact development site planning principles to help control stormwater volume impacts.	Flood, Drought, Riverine Erosion, High Winds	Moderate	Wake Planning and Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-9	Study the possibility of revising the zoning ordinance to include impervious surface standards that help minimize impervious surface coverage in priority and healthy watersheds. Wake County opted for use of NRCS Curve Number approach, which is superior to impervious surface standards.	Flood, Drought, Riverine Erosion	Moderate	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-10	Implement post-construction stormwater runoff controls to address additional runoff volume from new development and issues related to flooding created from higher peak runoff rates.	Flood, Drought, Riverine Erosion	Moderate	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-11	Study the possibility of charging offset fees for development that exceeds set impervious surface ratios in priority watersheds.	Flood, Drought, Riverine Erosion	Moderate	N/A	Local	Deleted	Stormwater Management Task Force did not recommend this action. Board of Commissioners agreed.
P-12	Ensure sensitive site design through reviewing development plans, meeting with customers, and site inspections.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-13	Update the design manual for erosion control to include the newest, most effective site design technologies. Train staff on new techniques.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
P-14	Enhance erosion and sedimentation control programs, primarily through enhanced enforcement.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-15	Continue the stream monitoring program and seek to maximize efforts through coordination with other organizations.	Flood, Drought, Riverine Erosion	High	Wake Planning, Environmental Services, Municipalities, DENR-WQ, USGS, Ecosystems Enhancement Program	Local, Regional, State, Federal	Complete	This action was completed and will be removed from the next plan update.
P-16	Develop an Environmental Monitoring Program to evaluate current water quality conditions and monitor impacts of growth and development on the health and condition of water resources in the future.	Flood, Drought, Riverine Erosion	High	Wake Planning, Environmental Services, Municipalities, DENR-WQ, USGS, Ecosystems Enhancement Program	Local, Regional, State, Federal	2017-2019	In progress. Wake County is partnering with UNRBA to do ongoing stream monitoring in the Falls Lake watershed for the next 3-5 years.
P-17	Maintain an open space prioritization and acquisition program to ensure maximum success with limited funds.	Flood, Drought	High	Wake Land Acquisition Review Committee, Open Space and Parks Advisory Committee, Contractors, Municipalities, TJCOG, Trust for Public Lands, and Triangle Land Conservancy	Local, Regional, State, Federal	Complete	This action was completed and will be removed from the next plan update.
P-18	Partner with other governmental units and other interested parties to jointly identify and acquire 30,000 acres of open space lands.	Flood, Drought	High	Municipalities, State of NC, NC State University, Trust for Public Lands, and Triangle Land Conservancy	Local, Private, State, Federal	2019, with long term goal of Approx. 25-30 years	The County has purchased approximately 5,000 acres since the program's inception. It will take several decades as indicated to complete.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
P-19	Oversee completion of planned reclaimed water projects per the County's approved Community Improvement Program (CIP).	Drought	Moderate	Raleigh, Wake County	Local	2019-2021	Completed several reclaimed water projects in RTP and others directly related to County facilities. More projects are in the works going forward.
P-20	Perform demonstration projects for rainwater harvesting, nutrient reductions and runoff reductions and water conservation.	Drought	Moderate	Wake Soil and Water Conservation	Local	Complete	This action was completed and will be removed from the next plan update.
P-21	Develop enhanced information about water saving devices.	Drought	Moderate	Wake Soil and Water Conservation	Local	Complete	This action was completed and will be removed from the next plan update.
Property Protection							
PP-1	Continue to utilize Federal and State grants to address structures in floodplains: acquire and remove from the floodplain; or renovate, retrofit and/or elevate structures flooded after a President or State declared disaster.	Flood	Moderate	Wake Environmental Services, Finance-Risk Management, and General Services Administration	Federal, State, Local	Delete	The County is not actively seeking grants to address floodplain structures. The County will pursue it if an when the circumstances arise.
PP-2	Continue to provide service to inform and advise citizens of the actions they may take to improve drainage, halt erosion, and to relocate, renovate or retrofit structures being flooded.	Flood, Drought, Riverine Erosion	Moderate	Wake Environmental Services	Local, Private	Complete	This action was completed and will be removed from the next plan update.
Natural Resource Protection							
NRP-1	Continue local program to enforce Erosion and Sedimentation Control Standards. Cross train ES employees in other disciplines to improve efficiency.	Flood, Drought, Riverine Erosion	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
NRP-2	Employ a variety of regulated Best Management Practices (BMPs) in the Stormwater Program to reduce peak flows, provide groundwater recharge, etc. One-year and (sometimes) 10-year storm event design required. 100-year spillway capacity always required.	Flood, Drought, Riverine Erosion	Moderate	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
NRP-3	Consider regulations to regulate clear-cutting to help control erosion from construction sites.	Flood, Drought, Riverine Erosion	Moderate	Wake Environmental Services, Planning, and Community Services	Local	Complete	This action was completed and will be removed from the next plan update.
NRP-4	Maintain the County's cluster and open space subdivision regulations and recreation land dedication ordinance to enhance conservation efforts.	All	High	Wake Environmental Services, Planning, and Community Services	Local	Complete	This action was completed and will be removed from the next plan update.
NRP-5	Study the possibility of developing a conservation subdivision, or open space subdivision, ordinance to help preserve significant natural features.	All	Moderate	Wake Environmental Services, Planning, and Community Services	Local	Complete	This action was completed and will be removed from the next plan update.
Structural Projects							
SP-1	Inspection and maintenance of Crabtree Creek flood control structures.	Flood	High	Wake General Services Administration	Local	Complete	This action was completed and will be removed from the next plan update.
SP-2	Channel Maintenance - Possibility of private property owner assistance program to be investigated as part of stormwater utility feasibility study.	Flood, Riverine Erosion	High	Wake Environmental Services	Local	Delete	Stormwater Management Task Force did not recommend this action. Board of Commissioners agreed.
SP-3	Pursue stream restoration projects and will look for ways to expand the program through partnerships with various entities.	Flood, Riverine Erosion	High	Wake Environmental Services , Community Services, DENR-WQ Ecosystems Enhancement Program, USACE	Local, Regional, State, Federal	Complete	This action was completed and will be removed from the next plan update.
Emergency Services							
ES-1	Identify priority County facilities and provide access to one main entrance. Restore life safety and building systems as needed.	All	High	Wake General Services Administration	Local, FEMA	Complete	This action was completed and will be removed from the next plan update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
ES-2	Develop a Business Continuity Plan, the primary document housing all disaster related plans and procedures.	All	High	Wake Emergency Management	Local	Complete	This action was completed and will be removed from the next plan update.
ES-3	Oversee completion of planned equipment replacements/upgrades for 800 MGHZ emergency communications systems, EMS facilities, and fire/rescue facilities per the approved capital improvement program.	All	High	Wake Facilities Design and Construction	Local	December 2018	In progress. The 800 MGHZ replacements are underway and scheduled for completion in 2018.
Public Education and Awareness							
PEA-1	Provide monitoring and enforcement of Wake County flood hazard regulations.	Flood	Moderate	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-2	Provide flood zone information through call-in or e-mail program to any inquirer. County requires showing flood zone information on all plats recorded in County planning jurisdiction.	Flood	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-3	Maintain a web site to answer citizen questions about flood hazards, flood safety, availability of flood insurance, stormwater regulations, and other information.	Flood	Moderate	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-4	Partner with Raleigh to use the "Communicator" application that will use GIS to develop automated call lists to warn residents of impending floods	Flood	High	Emergency Management & GIS	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-5	Maintain Environmental Network Call Center. Citizens may report flooding problems, pollution issues, erosion problems, infrastructure damage, littering, etc.	All	Moderate	Wake Environmental Services	Local	2019	This call center is in place, but a review and update of the system will be likely in the coming years.
PEA-6	Adopt updates to floodplain maps. Staff will review maps and identify all structures in floodplains and notify property owners of the risks and availability of flood insurance. List forwarded to Emergency Management.	Flood	High	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.

Action #	Description	Hazard(s) Addressed	Relative Priority	Lead Agency/ Department	Potential Funding Sources	Implementation Schedule	Implementation Status (2014)
PEA-7	Maintain flood elevation certificates.	Flood	Moderate	Wake Environmental Services and Community Services	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-8	Update flood hazard maps to reflect new subdivisions, changes in corporate limits, and any new DFIRM data.	Flood	Moderate	Wake GIS	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-9	Continue to use the State's Residential Property Disclosure Statement that includes check off on whether or not the property being offered for sale is within a Federally-designated floodplain.	Flood	Moderate	State of NC, Realtors	State	Delete	The county is not responsible for this action, but the state and realtors are ensuring that this is taking place.
PEA-10	Continue to make flood protection educational materials available.	Flood	Moderate	Wake Environmental Services	Local	Complete	This action was completed and will be removed from the next plan update.
PEA-11	Provide environmental education classes for development community and residents using Clearwater Contractor Education Program as model.	Flood	High	Wake Environmental Services, Community Services, and Municipalities	Local, State	Delete	Insufficient staff resources to accomplish this action.
PEA-12	Consider a countywide stormwater call center to improve response time to customers, provide an educational component, and allow stormwater staff to devote more time to solving problems	Flood	High	Wake Environmental Services, Community Services, and Municipalities	Local, State	Delete	Insufficient staff resources to accomplish this action.
PEA-13	Develop common public education materials and programs to inform the public on stormwater issues and convince them to change their behaviors accordingly.	Flood, Drought, Riverine Erosion	Moderate	Wake County Soil and Water Conservation	Local, State	Complete	This action was completed and will be removed from the next plan update.

Appendix A
Plan Adoption

This appendix includes the local adoption resolutions for each of the participating jurisdictions.

Appendix B
Planning Tools

This appendix includes the following:

1. Blank Public Survey (English and Spanish)
2. GIS Data Inventory Sheet
3. Scoring Criteria for Capability Assessment
4. Blank Mitigation Action Worksheet

PUBLIC SURVEY
FOR HAZARD MITIGATION PLANNING

We need your help!

Wake County is working together to become less vulnerable to natural disasters, and your participation is important to us!

The county, along with local jurisdictions and other partners, are working to prepare a multi-jurisdictional *Hazard Mitigation Plan*. This Plan will identify and assess our community's natural hazard risks and determine how to best minimize or manage those risks.

This survey is an opportunity for you to share your opinions and participate in the mitigation planning process. The information you provide will help us better understand your hazard concerns and can lead to mitigation activities that should help lessen the impacts of future hazard events.

Please help us by completing this survey by March 30, 2014 and returning it to:

Sara Reynolds, Atkins 1616 E Millbrook Road, Suite 310 Raleigh, NC 27609

Surveys can also be faxed to: (919) 876-6848 or emailed to sara.reynolds@atkinsglobal.com

If you have any questions regarding this survey or would like to learn about more ways you can participate in the development of the *Wake County Multi-Jurisdictional Hazard Mitigation Plan*, please contact Atkins, planning consultant for the project. You may reach Nathan Slaughter (Atkins) at 919-431-5251 or by email at nathan.slaughter@atkinsglobal.com. You can also visit the project website at http://wakecountyhazardplan.wikispaces.com/.

1. Where do you live?

- ❑ Unincorporated Wake County
- ❑ Apex
- ❑ Cary
- ❑ Fuquay-Varina
- ❑ Garner
- ❑ Holly Springs
- ❑ Knightdale
- ❑ Morrisville
- ❑ Raleigh
- ❑ Rolesville
- ❑ Wake Forest
- ❑ Wendell
- ❑ Zebulon
- ❑ Other: __________

2. Have you ever experienced or been impacted by a disaster?

- ❑ Yes
- ❑ No

a. If "Yes," please explain:

3. How concerned are you about the possibility of your community being impacted by a disaster?

- ❑ Extremely concerned
- ❑ Somewhat concerned
- ❑ Not concerned

4. Please select the <u>one</u> hazard you think is the *highest threat* to your neighborhood:

- ❑ Dam / Levee Failure
- ❑ Drought
- ❑ Earthquake
- ❑ Erosion
- ❑ Extreme Heat
- ❑ Flood
- ❑ Hailstorm
- ❑ Hazardous Materials Incident
- ❑ Hurricane / Tropical Storm
- ❑ Land Subsidence / Sink Hole
- ❑ Landslide
- ❑ Lightning
- ❑ Severe Winter Storm / Freeze
- ❑ Severe Thunderstorm / High Wind
- ❑ Tornado
- ❑ Wildfire

5. Please select the <u>one</u> hazard you think is the *second-highest threat* to your neighborhood:

- ❑ Dam / Levee Failure
- ❑ Drought
- ❑ Earthquake
- ❑ Erosion
- ❑ Extreme Heat
- ❑ Flood
- ❑ Hailstorm
- ❑ Hazardous Materials Incident
- ❑ Hurricane / Tropical Storm
- ❑ Land Subsidence / Sink Hole
- ❑ Landslide
- ❑ Lightning
- ❑ Severe Winter Storm / Freeze
- ❑ Severe Thunderstorm / High Wind
- ❑ Tornado
- ❑ Wildfire

6. Is there another hazard not listed above that you think is a wide-scale threat to your neighborhood?

- ❑ Yes (please explain): ____
- ❑ No

7. Is your home located in a FEMA floodplain?

- ❑ Yes
- ❑ No
- ❑ I don't know

8. Do you have flood insurance for your home/personal property?

- ❑ Yes
- ❑ No
- ❑ I don't know

a. If "No," why not?

- ❑ My home is not located in a floodplain
- ❑ I rent
- ❑ It's too expensive
- ❑ I don't need it because it never floods
- ❑ I don't need it because my home is elevated or otherwise protected
- ❑ I never really considered it
- ❑ Other (please explain): ____

9. Have you taken any actions to make your home, neighborhood, or family safer from hazards?

- ❑ Yes
- ❑ No

b. If "Yes," please explain:

10. Are you interested in making your home, neighborhood, or family more resistant to hazards?

- ❑ Yes
- ❑ No

11. Do you know what office to contact regarding risks from hazards in your area?

- ❑ Yes
- ❑ No

12. What is the most effective way for you to receive information about how to make your home, neighborhood, or family more resistant to hazards?

- ❑ Newspaper
- ❑ Television advertising
- ❑ Television programs
- ❑ Radio advertising
- ❑ Radio programs
- ❑ Internet
- ❑ Email
- ❑ Mail
- ❑ Public workshops/meetings
- ❑ School meetings
- ❑ Other (please explain): ____

13. In your opinion, what are some steps your local government could take to reduce the risk of future hazard damages in your neighborhood?

14. Are there any other issues regarding the risks and losses from hazards or disasters that you would like to mention?

15. **A number of community-wide activities can reduce vulnerability to hazards. In general, these activities fall into one of the following six broad categories. Please tell us how important you think each category is for your community to consider.**

Category	Very Important	Somewhat Important	Not Important
1. Prevention Administrative or regulatory actions that influence the way land is developed and buildings are built. Examples include planning and zoning, building codes, open space preservation, and floodplain regulations.	❑	❑	❑
2. Property Protection Actions that involve modification of existing buildings to protect them from a hazard or removal from the hazard area. Examples include acquisition, relocation, elevation, structural retrofits, and storm shutters.	❑	❑	❑
3. Natural Resource Protection Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems. Examples include: floodplain protection, habitat preservation, slope stabilization, riparian buffers, and forest management.	❑	❑	❑
4. Structural Projects Actions intended to lessen the impact of a hazard by modifying the natural progression of the hazard. Examples include dams, levees, detention/retention basins, channel modification, retaining walls, and storm sewers.	❑	❑	❑
5. Emergency Services Actions that protect people and property during and immediately after a hazard event. Examples include warning systems, evacuation planning, emergency response training, and protection of critical emergency facilities or systems.	❑	❑	❑
6. Public Education and Awareness Actions to inform citizens about hazards and the techniques they can use to protect themselves and their property. Examples include outreach projects, school education programs, library materials, and demonstration events.	❑	❑	❑

THANK YOU FOR YOUR PARTICIPATION!

This survey may be submitted anonymously; however, if you provide us with your name and contact information below we will have the ability to follow up with you to learn more about your ideas or concerns (optional):

Name: ____________________________

Address: ____________________________

____

Phone: ______________ **E-Mail:** ____________________

ENCUESTA PÚBLICA
PARA LA PLANIFICACIÓN DE MITIGACIÓN DE RIESGOS

¡Necesitamos su ayuda!

Condado Wake está trabajando en conjunto para llegar a ser menos vulnerables a los desastres naturales, y su participación es importante para nosotros!

El condado, junto con las jurisdicciones locales y otros asociados, están trabajando para preparar una multi-jurisdiccional *Plan de Mitigación de Riesgos*. Este Plan será determinar y evaluar los riesgos de peligros naturales de nuestra comunidad y determinar cómo minimizar mejor o gestionar esos riesgos.

Esta encuesta es una oportunidad para que comparta sus opiniones y participar en el proceso de planificación de la mitigación. La información que proporcione nos ayudará a entender mejor sus problemas de riesgo y puede dar lugar a actividades de mitigación que deberían ayudar a disminuir los efectos de los fenómenos extremos en el futuroa.

Por favor, ayúdenos completando esta encuesta el 30 de marzo de 2014 y la devolución:

Sara Reynolds, Atkins
1616 E Millbrook Road, Suite 310
Raleigh, NC 27609

Las encuestas también pueden ser enviados por fax al: (919) 876-6848 o por correo electrónico a sara.reynolds@atkinsglobal.com

Si usted tiene alguna pregunta sobre esta encuesta o si desea conocer más maneras de participar en el desarrollo del *Condado Wake Multijurisdiccional Plan de Mitigación de Riesgos*, por favor póngase en contacto con Atkins, consultor de planificación para el proyecto. Usted puede llegar a Nathan Slaughter (Atkins) al 919-431-5251 o por correo electronic a nathan.slaughter@atkinsglobal.com. También puede visitar el sitio web del proyecto http://wakecountyhazardplan.wikispaces.com/.

1. ¿Dónde vives?

- ❑ Condado Wake no Incorporado
- ❑ Apex
- ❑ Cary
- ❑ Fuquay-Varina
- ❑ Garner
- ❑ Holly Springs
- ❑ Knightdale
- ❑ Morrisville
- ❑ Raleigh
- ❑ Rolesville
- ❑ Wake Forest
- ❑ Wendell
- ❑ Zebulon
- ❑ Otro: __________

2. ¿Alguna vez ha experimentado o ha sido afectada por un desastre explique?

- ❑ Sí
- ❑ No

a. Si respondió "Sí", por favor explique:

3. ¿Cuánto se preocupa usted acerca de la posibilidad de su comunidad está afectada por un desastre vecindario?

- ❑ Extremadamente preocupado
- ❑ Poco preocupado
- ❑ Que no afecta

4. Por favor, selecciona el peligro que usted piensa es la *más alta amenaza* a su:

- ❑ Presa / Levee Fracaso
- ❑ Sequía
- ❑ Terremoto
- ❑ Erosión
- ❑ Calor Extremo
- ❑ Inundaciones
- ❑ Granizo
- ❑ Incidentes de Materiales Peligrosos
- ❑ El Huracán / Tormenta Tropical
- ❑ Hundimiento de La Tierra / Sumidero
- ❑ Corrimiento de Tierras
- ❑ Relámpago
- ❑ Severo Winter Storm / Helada
- ❑ Tormenta Severa / Alto Viento
- ❑ Tornado
- ❑ Incendios Forestales

5. Por favor, seleccione el peligro crees que es el *segundo-más alta amenaza* a su vecindario:

- ❑ Presa / Levee Fracaso
- ❑ Sequía
- ❑ Terremoto
- ❑ Erosión
- ❑ Calor Extremo
- ❑ Inundaciones
- ❑ Granizo
- ❑ Incidentes de Materiales Peligrosos
- ❑ El Huracán / Tormenta Tropical
- ❑ Hundimiento de La Tierra / Sumidero
- ❑ Corrimiento de Tierras
- ❑ Relámpago
- ❑ Severo Tormenta de Invierno / Helada
- ❑ Tormenta Severa / Alto Viento
- ❑ Tornado
- ❑ Incendios Forestales

6. ¿Hay otro peligro no mencionados anteriormente que usted cree que es una amenaza a gran escala para su vecindario?

- ❑ Sí (por favor explique): ____
- ❑ No

7. ¿Es su casa situada en una llanura de inundación de FEMA?

- ❑ Sí
- ❑ No
- ❑ No sé

8. ¿Tiene usted seguro de inundación para su hogar / propiedad personal?

- ❑ Sí
- ❑ No
- ❑ No sé

a. Si es "No", ¿por qué no?

- ❑ Mi casa no está situado en una llanura de inundación
- ❑ Alquilo
- ❑ Es demasiado caro
- ❑ Que no lo necesito porque nuncainunda
- ❑ Meno lo necesito porque mi casa está elevada o protegido de otra manera
- ❑ Nunca me consideré
- ❑ Otro (por favor explique): ______________________________

9. ¿Se ha tomado ninguna acción para hacer de su hogar , barrio o de la familia más a salvo de los peligros explique?

- ❑ Sí
- ❑ No

b. Si respondió "Sí", por favor explique:

10. ¿Está usted interesado en hacer de su hogar, el vecindario o la familia más resistentes a los peligrosen?

- ❑ Sí
- ❑ No

11. ¿Sabes lo que la oficina para contactar acerca de los riesgos derivados de los peligros su área?

- ❑ Yes
- ❑ No

12. ¿Cuál es la manera más eficaz para que usted pueda recibir información sobre cómo hacer de su hogar, el vecindario o la familia más resistentes a los peligros?

- ❑ Periódico
- ❑ Televisión publicidad
- ❑ Programas de televisión
- ❑ Radiode publicidad
- ❑ Programas radiales
- ❑ en Internet
- ❑ Correo electrónico
- ❑ Correo
- ❑ Públicas talleres / reunions escolares
- ❑ Reuniones escolares
- ❑ Otros (por favor explique): ____

13. En su opinión, ¿cuáles son algunos pasos que su gobierno local podría tomar para reducir el riesgo de daños futuros peligros en su vecindario?

14. ¿Existen otras cuestiones relativas a los riesgos y las pérdidas de los peligros o desastres que le gustaría mencionar?

15. **Una serie de actividades para toda la comunidad puede reducir la vulnerabilidad a los peligros. En general, estas actividades caen en una de las siguientes seis categorías amplias. Por favor díganos lo importante que piensas cada categoría es para su comunidad a considerar.**

Categoría	Muy Importante	Algo Importante	Importante No
1. Prevención Administrativo o acciones reguladoras que influyen en la forma en que la tierra se desarrolla y los edificios están construidos. Los ejemplos incluyen la planificación y zonificación, códigos de construcción, preservación de espacios abiertos, y los reglamentos de llanuras de inundación.	❑	❑	❑
2. Protección de La Propiedad Acciones que implican la modificación de los edificios existentes para protegerlos de un peligro o la retirada de la zona de peligro. Los ejemplos incluyen la adquisición, traslado, elevación, modernizaciones estructurales y tormenteras.	❑	❑	❑
3. Protección de Los Recursos Naturales Acciones que, además de reducir al mínimo las pérdidas de peligro, también preservar o restaurar las funciones de los sistemas naturales. Algunos ejemplos son: la protección llanura de inundación, la preservación del hábitat, estabilización de taludes, zonas de amortiguación ribereñas, y el manejo forestal.	❑	❑	❑
4. Proyectos Estructurales Acciones de stinadas a disminuir el impacto de un riesgo al modificar la evolución natural de la amenaza. Los ejemplos incluyen presas, diques, cuencas de detención / retención, modificación de canales, muros de contención y drenajes pluviales.	❑	❑	❑
5. Servicios de Emergencia Medidas para proteger personas y bienes durante e inmediatamente después de un evento peligroso. Los ejemplos incluyen sistemas de alerta, planes de evacuación, capacitación de respuesta a emergencias y la protección de las instalaciones o sistemas de emergencia críticos.	❑	❑	❑
6. Educación y Conciencia Pública Las acciones para informar a los ciudadanos sobre los peligros y las técnicas que se pueden utilizar para protegerse a sí mismos ya su propiedad. Los ejemplos incluyen proyectos de extensión, programas de educación escolar, materiales de la biblioteca, y eventos de demostraciónanónima.	❑	❑	❑

¡GRACIAS POR SU PARTICIPACIÓN!

Esta encuesta puede ser enviado de forma Sin embargo, si usted nos proporciona con su nombre e información de contacto a continuación vamos a tener la capacidad de seguimiento con usted para aprender más sobre sus ideas o preocupaciones (opcional):

Nombre: ______________________________

Dirección: ______________________________

____

Teléfono: ______________ **E-Mail:** ______________________

GIS Data Request Sheet
Wake County Multi-Jurisdictional Hazard Mitigation Plan

Data requested	Available?	Received?	Potential Sources
Tax Parcel Data			Tax Assessor
including replacement value			
Building Footprints			Tax Assessor/GIS office
Critical Facilities (in GIS or list form with addresses)			Tax Assessor/GIS office
examples include:			
government buildings			
hospitals			
senior care			
police/fire/EMS/EOC			
locally significant buildings			
schools			
Local hazard studies			public works, natural resources, planning
examples include:			
Flood Studies (HEC-RAS, Risk MAP)			
Local Hazard History Articles			
Areas of Concern Studies			

If you have any questions, please contact:

Nathan Slaughter
nathan.slaughter@atkinsglobal.com
919-431-5251

Points System for Capability Ranking

0-19 points = Limited overall capability **20-39 points = Moderate overall capability** **40-68 points = High overall capability**

I. Planning and Regulatory Capability
(Up to 43 points)

Yes = 3 points
Under Development = 1 point
Included under County plan/code/ordinance/program = 1 point
No = 0 points

- Hazard Mitigation Plan
- Comprehensive Land Use Plan
- Floodplain Management Plan
- National Flood Insurance Program
- NFIP Community Rating System

Yes = 2 points
Under Development = 1 point
Included under County plan/code/ordinance/program = 1 point
No = 0 points

- Open Space Management Plan / Parks & Recreation Plan
- Stormwater Management Plan
- Natural Resource Protection Plan
- Flood Response Plan
- Emergency Operations Plan
- Continuity of Operations Plan
- Evacuation Plan
- Disaster Recovery Plan
- Flood Damage Prevention Ordinance
- Post-disaster Redevelopment / Reconstruction Ordinance

Yes = 1 point
No = 0 points

- Capital Improvements Plan
- Economic Development Plan
- Historic Preservation Plan
- Zoning Ordinance
- Subdivision Ordinance
- Unified Development Ordinance
- Building Code
- Fire Code

II. Administrative and Technical Capability
(Up to 15 points)

Yes = 2 points
Service provided by County = 1 point
No = 0 points

- Planners with knowledge of land development and land management practices
- Engineers or professionals trained in construction practices related to buildings and/or infrastructure
- Planners or engineers with an understanding of natural and/or human-caused hazards
- Emergency manager
- Floodplain manager

Yes = 1 point
No = 0 points

- Land surveyors
- Scientist familiar with the hazards of the community
- Staff with education or expertise to assess the community's vulnerability to hazards
- Personnel skilled in Geographical Information Systems (GIS) and/or Hazus
- Resource development staff or grant writers

III. Fiscal Capability
(Up to 10 points)

Yes = 1 point
No = 0 points

- Capital Improvement Programming
- Community Development Block Grants (CDBG)
- Special Purpose Taxes (or tax districts)
- Gas / Electric Utility Fees
- Water / Sewer Fees
- Stormwater Utility Fees
- Development Impact Fees
- General Obligation / Revenue / Special Tax Bonds
- Partnering arrangements or intergovernmental agreements
- Other

MITIGATION ACTION WORKSHEETS

Mitigation Action Worksheets are used to identify potential hazard mitigation actions that participating jurisdictions in Wake County will consider to reduce the negative effects of identified hazards. The worksheets provide a simple yet effective method of organizing potential actions in a user-friendly manner that can easily be incorporated into the Wake County Hazard Mitigation Plan.

The worksheets are to be used as part of a strategic planning process and are designed to be:

a.) completed electronically (worksheets and instructions will be e-mailed to members of the Regional Hazard Mitigation Work Group Members);

b.) reviewed with your department/organization for further consideration; and

c.) returned according to the contact information provided below.

Please return all completed worksheets no later than February 28, 2014 to:

Nathan Slaughter, Project Manager Atkins

Electronic copies may be e-mailed to: nathan.slaughter@atkinsglobal.com

Hard copies may be faxed to: 919-876-6848 (Attn: Nathan Slaughter)

INSTRUCTIONS

Each mitigation action should be considered to be a separate local project, policy or program and each individual action should be entered into a separate worksheet. By identifying the implementation requirements for each action, the worksheets will help lay the framework for engaging in distinct actions that will help reduce the community's overall vulnerability and risk. Detailed explanations on how to complete the worksheet are provided below.

Proposed Action: Identify a specific action that, if accomplished, will reduce vulnerability and risk in the impact area. Actions may be in the form of local policies (i.e., regulatory or incentive-based measures), programs or structural mitigation projects and should be consistent with any pre-identified mitigation goals and objectives.

Site and Location: Provide details with regard to the physical location or geographic extent of the proposed action, such as the location of a specific structure to be mitigated, whether a program will be citywide, countywide or regional, etc.

History of Damages: Provide a brief history of any known damages as it relates to the proposed action and the hazard(s) being addressed. For example, the proposed elevation of a repetitive loss property should include an overview of the number of times the structure has flooded, total dollar amount of damages if available, etc.

Hazard(s) Addressed: List the hazard(s) the proposed action is designed to mitigate against.

Category: Indicate the most appropriate category for the proposed action as discussed during the Mitigation Strategy Workshop (Prevention; Property Protection; Natural Resource Protection; Structural Projects; Emergency Services; Public Education and Awareness).

Priority: Indicate whether the action is a "high" priority, "moderate" priority or "low" priority based generally on the following criteria:

1. Effect on overall risk to life and property
2. Ease of implementation / technical feasibility
3. Project costs versus benefits
4. Political and community support
5. Funding availability

Estimated Cost: If applicable, indicate what the total cost will be to accomplish this action. This amount will be an estimate until actual final dollar amounts can be determined. Some actions (such as ordinance revisions) may only cost "local staff time" and should be noted so.

Potential Funding Sources: If applicable, indicate how the cost to complete the action will be funded. For example, funds may be provided from existing operating budgets or general funds, a previously established contingency fund, a cost-sharing federal or state grant program, etc.

Lead Agency/Department Responsible: Identify the local agency, department or organization that is best suited to implement the proposed action.

Implementation Schedule: Indicate when the action will begin and when the action is expected to be completed. Remember that some actions will require only a minimal amount of time, while others may require a long-term or continuous effort.

Comments: This space is provided for any additional information or details that may not be captured under the previous headings.

	MITIGATION ACTION
Proposed Action:	
BACKGROUND INFORMATION	
Site and Location:	
History of Damages:	

MITIGATION ACTION DETAILS	
Hazard(s) Addressed:	
Category:	
Priority (High, Moderate, Low):	
Estimated Cost:	
Potential Funding Sources:	
Lead Agency/Department Responsible:	
Implementation Schedule:	

COMMENTS

Appendix C
Local Mitigation Plan Review Tool

LOCAL MITIGATION PLAN REVIEW TOOL

The *Local Mitigation Plan Review Tool* demonstrates how the Local Mitigation Plan meets the regulation in 44 CFR §201.6 and offers States and FEMA Mitigation Planners an opportunity to provide feedback to the community.

- The Regulation Checklist provides a summary of FEMA's evaluation of whether the Plan has addressed all requirements.
- The Plan Assessment identifies the plan's strengths as well as documents areas for future improvement.
- The Multi-jurisdiction Summary Sheet is an optional worksheet that can be used to document how each jurisdiction met the requirements of the each Element of the Plan (Planning Process; Hazard Identification and Risk Assessment; Mitigation Strategy; Plan Review, Evaluation, and Implementation; and Plan Adoption).

The FEMA Mitigation Planner must reference this *Local Mitigation Plan Review Guide* when completing the *Local Mitigation Plan Review Tool*.

Jurisdiction: Wake County	**Title of Plan:** Wake County Multi-Jurisdictional Hazard Mitigation Plan	**Date of Plan:** May 2014

Local Point of Contact: **Josh Creighton**	**Address:** **Wake County Emergency Management** **331 S. McDowell St.** **Raleigh, NC 27601**
Title: **Deputy Director**	
Agency: **Wake County Emergency Management**	
Phone Number: **919-856-6485**	**E-Mail:** **Joshua.creighton@wakegov.com**

State Reviewer:	**Title:**	**Date:**

FEMA Reviewer:	**Title:**	**Date:**
Date Received in FEMA Region ***(insert #)***		
Plan Not Approved		
Plan Approvable Pending Adoption		
Plan Approved		

SECTION 1:
REGULATION CHECKLIST

INSTRUCTIONS: The Regulation Checklist must be completed by FEMA. The purpose of the Checklist is to identify the location of relevant or applicable content in the Plan by Element/sub-element and to determine if each requirement has been 'Met' or 'Not Met.' The 'Required Revisions' summary at the bottom of each Element must be completed by FEMA to provide a clear explanation of the revisions that are required for plan approval. Required revisions must be explained for each plan sub-element that is 'Not Met.' Sub-elements should be referenced in each summary by using the appropriate numbers (A1, B3, etc.), where applicable. Requirements for each Element and sub-element are described in detail in this *Plan Review Guide* in Section 4, Regulation Checklist.

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
ELEMENT A. PLANNING PROCESS			
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	Section 2; App. D		
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	Section 2.4-2.6, Section 2.7; App. D		
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	Section 2.7; App. F		
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	Section 7.3; Jurisdiction-specific annexes (X.4)		
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	Section 10.3		
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	Section 10.2		
ELEMENT A: REQUIRED REVISIONS			
ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))	Section 4; Section 5; Jurisdiction-specific annexes (X.2)		

1. REGULATION CHECKLIST Regulation (44 CFR 201.6 Local Mitigation Plans)	Location in Plan (section and/or page number)	Met	Not Met
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))	Section 5; Jurisdiction-specific annexes (X.2)		
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))	Section 5; Section 6; Jurisdiction-specific annexes (X.2 and X.3)		
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))	Section 5.15.5; Jurisdiction-specific annexes (X.2.13)		
ELEMENT B: REQUIRED REVISIONS			
ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))	Section 7; Jurisdiction-specific annexes (X.4)		
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))	Section 5.15.4; Section 7.3.4; Jurisdiction-specific annexes (X.4.1)		
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))	Section 8.2; Jurisdiction-specific annexes (X.5.1)		
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))	Section 8.3-8.4; Section 9.2; Jurisdiction-specific annexes (X.5.2)		
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))	Section 8.1.1; Section 9.2; Jurisdiction-specific annexes (X.5.2)		
C6. Does the Plan describe a process by which local governments will integrate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate? (Requirement §201.6(c)(4)(ii))	Section 7.3.1 (Table 7.1); Section 10.1; Jurisdiction-specific annexes (X.4.1)		
ELEMENT C: REQUIRED REVISIONS			
ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))	Section 6.4.3		

1. REGULATION CHECKLIST **Regulation** (44 CFR 201.6 Local Mitigation Plans)	**Location in Plan** (section and/or page number)	**Met**	**Not Met**
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))	Section 2.8; Section 8.5; Jurisdiction-specific annexes (X.5.2)		
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))	Section 5.21 (Table 5.75); Section 9.2; Jurisdiction-specific annexes (X.2.16 and X.5.2)		
ELEMENT D: REQUIRED REVISIONS			
ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))	App. A		
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))	App. A		
ELEMENT E: REQUIRED REVISIONS			
ELEMENT F. ADDITIONAL STATE REQUIREMENTS (OPTIONAL FOR STATE REVIEWERS ONLY; NOT TO BE COMPLETED BY FEMA)			
F1.			
F2.			
ELEMENT F: REQUIRED REVISIONS			

SECTION 2:
PLAN ASSESSMENT

INSTRUCTIONS: The purpose of the Plan Assessment is to offer the local community more comprehensive feedback to the community on the quality and utility of the plan in a narrative format. The audience for the Plan Assessment is not only the plan developer/local community planner, but also elected officials, local departments and agencies, and others involved in implementing the Local Mitigation Plan. The Plan Assessment must be completed by FEMA. The Assessment is an opportunity for FEMA to provide feedback and information to the community on: 1) suggested improvements to the Plan; 2) specific sections in the Plan where the community has gone above and beyond minimum requirements; 3) recommendations for plan implementation; and 4) ongoing partnership(s) and information on other FEMA programs, specifically RiskMAP and Hazard Mitigation Assistance programs. The Plan Assessment is divided into two sections:

1. Plan Strengths and Opportunities for Improvement
2. Resources for Implementing Your Approved Plan

Plan Strengths and Opportunities for Improvement is organized according to the plan Elements listed in the Regulation Checklist. Each Element includes a series of italicized bulleted items that are suggested topics for consideration while evaluating plans, but it is not intended to be a comprehensive list. FEMA Mitigation Planners are not required to answer each bullet item, and should use them as a guide to paraphrase their own written assessment (2-3 sentences) of each Element.

The Plan Assessment must not reiterate the required revisions from the Regulation Checklist or be regulatory in nature, and should be open-ended and to provide the community with suggestions for improvements or recommended revisions. The recommended revisions are suggestions for improvement and are not required to be made for the Plan to meet Federal regulatory requirements. The italicized text should be deleted once FEMA has added comments regarding strengths of the plan and potential improvements for future plan revisions. It is recommended that the Plan Assessment be a short synopsis of the overall strengths and weaknesses of the Plan (no longer than two pages), rather than a complete recap section by section.

Resources for Implementing Your Approved Plan provides a place for FEMA to offer information, data sources and general suggestions on the overall plan implementation and maintenance process. Information on other possible sources of assistance including, but not limited to, existing publications, grant funding or training opportunities, can be provided. States may add state and local resources, if available.

A. Plan Strengths and Opportunities for Improvement

This section provides a discussion of the strengths of the plan document and identifies areas where these could be improved beyond minimum requirements.

Element A: Planning Process

How does the Plan go above and beyond minimum requirements to document the planning process with respect to:

- *Involvement of stakeholders (elected officials/decision makers, plan implementers, business owners, academic institutions, utility companies, water/sanitation districts, etc.);*
- *Involvement of Planning, Emergency Management, Public Works Departments or other planning agencies (i.e., regional planning councils);*
- *Diverse methods of participation (meetings, surveys, online, etc.); and*
- *Reflective of an open and inclusive public involvement process.*

Element B: Hazard Identification and Risk Assessment

In addition to the requirements listed in the Regulation Checklist, 44 CFR 201.6 Local Mitigation Plans identifies additional elements that should be included as part of a plan's risk assessment. The plan should describe vulnerability in terms of:

1) *A general description of land uses and future development trends within the community so that mitigation options can be considered in future land use decisions;*
2) *The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas; and*
3) *A description of potential dollar losses to vulnerable structures, and a description of the methodology used to prepare the estimate.*

How does the Plan go above and beyond minimum requirements to document the Hazard Identification and Risk Assessment with respect to:

- *Use of best available data (flood maps, HAZUS, flood studies) to describe significant hazards;*
- *Communication of risk on people, property, and infrastructure to the public (through tables, charts, maps, photos, etc.);*
- *Incorporation of techniques and methodologies to estimate dollar losses to vulnerable structures;*
- *Incorporation of Risk MAP products (i.e., depth grids, Flood Risk Report, Changes Since Last FIRM, Areas of Mitigation Interest, etc.); and*
- *Identification of any data gaps that can be filled as new data became available.*

Element C: Mitigation Strategy

How does the Plan go above and beyond minimum requirements to document the Mitigation Strategy with respect to:

- *Key problems identified in, and linkages to, the vulnerability assessment;*
- *Serving as a blueprint for reducing potential losses identified in the Hazard Identification and Risk Assessment;*
- *Plan content flow from the risk assessment (problem identification) to goal setting to mitigation action development;*
- *An understanding of mitigation principles (diversity of actions that include structural projects, preventative measures, outreach activities, property protection measures, post-disaster actions, etc);*
- *Specific mitigation actions for each participating jurisdictions that reflects their unique risks and capabilities;*
- *Integration of mitigation actions with existing local authorities, policies, programs, and resources; and*
- *Discussion of existing programs (including the NFIP), plans, and policies that could be used to implement mitigation, as well as document past projects.*

Element D: Plan Update, Evaluation, and Implementation (*Plan Updates Only*)

How does the Plan go above and beyond minimum requirements to document the 5-year Evaluation and Implementation measures with respect to:

- *Status of previously recommended mitigation actions;*
- *Identification of barriers or obstacles to successful implementation or completion of mitigation actions, along with possible solutions for overcoming risk;*
- *Documentation of annual reviews and committee involvement;*
- *Identification of a lead person to take ownership of, and champion the Plan;*
- *Reducing risks from natural hazards and serving as a guide for decisions makers as they commit resources to reducing the effects of natural hazards;*
- *An approach to evaluating future conditions (i.e. socio-economic, environmental, demographic, change in built environment etc.);*
- *Discussion of how changing conditions and opportunities could impact community resilience in the long term; and*
- *Discussion of how the mitigation goals and actions support the long-term community vision for increased resilience.*

B. Resources for Implementing Your Approved Plan

Ideas may be offered on moving the mitigation plan forward and continuing the relationship with key mitigation stakeholders such as the following:

- *What FEMA assistance (funding) programs are available (for example, Hazard Mitigation Assistance (HMA)) to the jurisdiction(s) to assist with implementing the mitigation actions?*
- *What other Federal programs (National Flood Insurance Program (NFIP), Community Rating System (CRS), Risk MAP, etc.) may provide assistance for mitigation activities?*
- *What publications, technical guidance or other resources are available to the jurisdiction(s) relevant to the identified mitigation actions?*
- *Are there upcoming trainings/workshops (Benefit-Cost Analysis (BCA), HMA, etc.) to assist the jurisdictions(s)?*
- *What mitigation actions can be funded by other Federal agencies (for example, U.S. Forest Service, National Oceanic and Atmospheric Administration (NOAA), Environmental Protection Agency (EPA) Smart Growth, Housing and Urban Development (HUD) Sustainable Communities, etc.) and/or state and local agencies?*

SECTION 3:
MULTI-JURISDICTION SUMMARY SHEET (OPTIONAL)

INSTRUCTIONS: For multi-jurisdictional plans, a Multi-jurisdiction Summary Spreadsheet may be completed by listing each participating jurisdiction, which required Elements for each jurisdiction were 'Met' or 'Not Met,' and when the adoption resolutions were received. This Summary Sheet does not imply that a mini-plan be developed for each jurisdiction; it should be used as an optional worksheet to ensure that each jurisdiction participating in the Plan has been documented and has met the requirements for those Elements (A through E).

MULTI-JURISDICTION SUMMARY SHEET													
#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)						
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
1	Wake County	County	Josh Creighton									
2	Town of Apex	Town	June Cowles									
3	Town of Cary	Town	Mary Beerman									
4	Town of Fuquay-Varina	Town	Samantha Smith									
5	Town of Garner	Town	Rodney Dickerson									
6	Town of Holly Springs	Town	Daniel Weeks									
7	Town of Knightdale	Town	Jeff Triezenberg									
8	Town of Morrisville	Town	Courtney Queen									

MULTI-JURISDICTION SUMMARY SHEET													
#	Jurisdiction Name	Jurisdiction Type (city/borough/ township/ village, etc.)	Plan POC	Mailing Address	Email	Phone	Requirements Met (Y/N)					
							A. Planning Process	B. Hazard Identification & Risk Assessment	C. Mitigation Strategy	D. Plan Review, Evaluation & Implementation	E. Plan Adoption	F. State Require-ments
9	City of Raleigh	City	Ben Brown									
10	Town of Rolesville	Town	Thomas Lloyd									
11	Town of Wake Forest	Town	Charlie Yokley									
12	Town of Wendell	Town	Patrick Reidy									
13	Town of Zebulon	Town	Julie Spriggs									
14												
15												
16												
17												
18												
19												
20												

Appendix D
Planning Process Documentation

This appendix includes:

1. Meeting Agendas
2. Meeting Minutes
3. Meeting Sign-In Sheets

AGENDA

Wake County Multi-Jurisdictional Hazard Mitigation Plan
West Wake Work Group Meeting

December 13, 2013
10:00 AM – Noon

1) **Introductions**
2) **Recap- Regional Work Groups**
3) **Risk Assessment Discussion**
   a) Review of Risk Assessment
   b) Hazard Identification
   c) Data
   d) Critical Facilities
4) **Mitigation Strategy Discussion**
   a) Review of Mitigation Strategy
   b) Mitigation Goals
   c) Updating Current Mitigation Actions
   d) Developing New Mitigation Actions
5) **Public Involvement**
6) **CRS**
7) **Next Steps**
   a) Data Collection
   b) Mitigation Actions
   c) Public Outreach
   d) Discuss next meeting
8) **Questions, Issues, or Concerns**

ATKINS

AGENDA

Wake County Multi-Jurisdictional Hazard Mitigation Plan
East Wake Work Group Meeting
Thursday, December 12, 2013
10:00 PM – Noon

1) **Introductions**

2) **Recap – Regional Work Groups**

3) **Risk Assessment Discussion**
   a) Hazard Identification – select hazards to evaluate
   b) Vulnerability Assessment

4) **Mitigation Action Review and Discussion**
   a) Present existing actions
   b) Discuss updating existing actions
   c) Discuss identification of new actions

5) **CRS Recap Q&A**

6) **Next Steps**
   a) Continue data collection efforts
   b) Continue public outreach
   c) Discuss next work group meeting

7) **Questions, Issues, or Concerns**

ATKINS

AGENDA

Wake County Multi-Jurisdictional Hazard Mitigation Plan
West Wake Work Group Meeting
Friday, December 13, 2013
10:00 PM – Noon

1) **Introductions**

2) **Recap Project Objectives and Discuss Expectations**

3) **Recap Project Overview**
   a) General approach
   b) County regions
   c) Project tasks

4) **Risk Assessment Discussion**
   a) Hazard Identification – select hazards to evaluate
   b) Vulnerability Assessment

5) **Data Collection Recap**
   a) GIS Data inventory
   b) Capability Assessment information
   c) Public outreach
   d) Existing mitigation actions

6) **Mitigation Action Review and Discussion**
   a) Present existing actions
   b) Discuss updating existing actions
   c) Discuss identification of new actions

7) **CRS Recap Q&A**

8) **Next Steps**
   a) Continue data collection efforts
   b) Continue public outreach
   c) Discuss next work group meeting

9) **Questions, Issues, or Concerns**

ATKINS

AGENDA

Wake County Multi-Jurisdictional Hazard Mitigation Plan
East Wake Work Group Meeting
Tuesday January 28, 2014
10:00 AM – Noon

1) **Introductions**
2) **Recap – What We're Working On Today**
3) **Risk Assessment Findings**
   a) Hazard History and Profiles
   b) Conclusions on Risk: PRI
   c) Critical Facilities
4) **Capability Assessment Findings**
   a) Indicators
   b) Results
5) **Mitigation Strategy**
   a) Current Goals/Actions
   b) New Actions
   c) Discussion
6) **Next Steps**
   a) Mitigation Actions
   b) Continue public outreach
   c) Core Committee Meeting
7) **Questions, Issues, or Concerns**

ATKINS

AGENDA

Wake County Multi-Jurisdictional Hazard Mitigation Plan
West Wake Work Group Meeting
Friday January 31, 2014
10:00 AM – Noon

1) **Introductions**
2) **Recap – What We're Working On Today**
3) **Risk Assessment Findings**
   a) Hazard History and Profiles
   b) Conclusions on Risk: PRI
   c) Critical Facilities
4) **Capability Assessment Findings**
   a) Indicators
   b) Results
5) **Mitigation Strategy**
   a) Current Goals/Actions
   b) New Actions
   c) Discussion
6) **Next Steps**
   a) Mitigation Actions
   b) Continue public outreach
   c) Core Committee Meeting
7) **Questions, Issues, or Concerns**

ATKINS

AGENDA

Wake County Multi-Jurisdictional Hazard Mitigation Plan
Coordinating Committee Meeting

April 1, 2014
3:00 PM

1) **Welcome and Introductions**

2) **Mitigation Overview**

3) **Project Overview**

4) **Present Initial Findings**

5) **Discuss Mitigation Actions**

6) **Next Steps**

7) **Questions, Issues, or Concerns**

ATKINS

AGENDA

Wake County Multi-Jurisdictional Hazard Mitigation Plan

Final Public Meeting

6:00 PM - December 30, 2014

222 W Hargett Street, Raleigh, NC Room 305

- Welcome and Introductions
- Mitigation Overview
- Project Summary
- Present Plan
- Public Survey Findings
- Next Steps

Meeting Minutes
Wake County Multi-Jurisdictional Hazard Mitigation Plan
Project Kickoff Meeting
November 21, 2013

Josh Creighton, Wake County Emergency Management Director, started the meeting by welcoming the representatives from the County, participating municipal jurisdictions, and other stakeholders. Mr. Creighton then introduced Nathan Slaughter, Project Manager from the project consulting team, Atkins.

Mr. Slaughter led the kickoff meeting and began by providing an overview of the items to be discussed at the meeting and briefly reviewed each of the handouts that were distributed in the meeting packets (agenda, project description, and presentation slides). He then asked each of the meeting attendees to introduce themselves. Following introductions, he provided a brief overview of mitigation and discussed the Disaster Mitigation Act of 2000 and NC Senate Bill 300.

He gave a list of the participating jurisdictions for the multi-jurisdictional plan, noting all local governments in the County are participating and have existing hazard mitigation plans. There was discussion about Knightdale's plan being the first to expire. It was determined that the Knightdale Annex will be a completed first and used as a template for the remaining jurisdiction-specific annexes.

Ryan Wiedenman from Atkins then explained the six different categories of mitigation techniques (emergency services; prevention; natural resource protection; structural projects; public education and awareness; and property protection) and gave examples of each. This explanation culminated to an Ice Breaker Exercise for the attendees.

Mr. Wiedenman instructed attendees on how to complete the exercise. Attendees were given an equal amount of fictitious FEMA money and asked to spend it in the various mitigation categories. Money could be thought of grant money that communities received towards mitigation. Attendees were asked to target their money towards areas of mitigation that are of greatest concern for their community. Ideally, the exercise helps pinpoint areas of mitigation that the community may want to focus on when developing mitigation grants. The Ice Breaker Exercise results were to be reviewed and presented at the conclusion of the meeting.

Mr. Slaughter then discussed the key objectives of the planning process and the structure of the hazard mitigation planning committee, which comprises a Coordinating Committee made up of local government and other stakeholders and smaller Regional Work Groups made up of local government staff and officials. Local governments were given the opportunity to discuss how the Regional Work Groups should be divided. It was determined that Knightdale, Rolesville, Wendell, Wake Forest and Zebulon will form the Eastern Wake County Work Group and Apex, Cary, Morrisville, Holly Springs, Fuquay-Varina, and Garner will form the Western Wake County Work Group. Raleigh and Wake County will participate on both groups. (This structure mirrors existing transportation planning efforts.)

Mr. Slaughter then explained the specific tasks to be accomplished for this project, including the planning process, risk assessment, vulnerability assessment, capability assessment, mitigation strategy and action plan, plan maintenance procedures, and documentation. The project schedule was presented along with the project staffing chart, which demonstrates the number of experienced individuals that will be working on this project.

The data collection needs and public outreach efforts were also discussed. Sarah Bruce from the Triangle J Council of Governments and member of the Atkins team explained the online wiki/project website that will be used during the project.

Mr. Slaughter then reviewed the roles and responsibilities of Atkins, participating jurisdictions, and stakeholders.

David Stroud from AMEC, also part of the Atkins team, then followed by providing an overview of the Community Rating System (CRS) program. CRS "what-if" scenarios were distributed to each local government to demonstrate how much citizens could save on flood insurance premiums under the CRS.

The presentation concluded with a discussion of the next steps to be taken in the project development, which included discussing data collection efforts, continuing public outreach, and the next meeting for the Coordinating Committee and Regional Work Groups.

The meeting was opened for questions and comments and several topics were raised including: outreach for special or disadvantaged populations, public survey availability, raising public awareness to ensure a fully-representative dataset, internal standing hazard mitigation committees, public health as vulnerability consideration, floodplain map updates.

Sara Reynolds from Atkins then presented the Ice Breaker Exercise results which were:

- Prevention—$177
- Structural Projects—$151
- Property Protection—$116
- Natural Resource Protection—$92
- Emergency Services—$64
- Public Education and Awareness—$60

The meeting was adjourned.

Meeting Minutes
Wake County Multi-Jurisdictional Hazard Mitigation Plan
East Wake Regional Work Group Meeting #1
December 12, 2013

Nathan Slaughter with Atkins, started the meeting by welcoming the representatives from the participating jurisdictions. Mr. Slaughter went on to discuss the purpose of the regional work groups which was to gain valuable input from local planners such as specific data and areas of risk.

Mr. Slaughter led the work group and began by providing an overview of the items to be discussed at the meeting and briefly reviewed each of the handouts that were distributed in the meeting packets (agenda and presentation slides). He then asked each of the meeting attendees to introduce themselves. Following introductions, he provided a brief overview of the stages of the mitigation planning process that would be addressed.

Ryan Wiedenman from Atkins then led the Risk Assessment discussion and explained the importance of identifying an accurate list of hazards that could potentially impact the jurisdictions. Mr. Wiedenman then presented a comprehensive list of hazards and led a discussion with the work group members until a list of hazards to be analyzed further was agreed upon.

Mr. Wiedenman then discussed the specific data needs for completing the risk assessment. Work group members were instructed to look into collecting building footprint and parcel data, as well as any local hazard studies that might have been carried out in the past. Mr. Wiedenman went on to explain the definition of critical facilities and how important they were to mitigation plans. This led to an exercise in which each local government representative was provided a list of critical facilities derived from both their current plans and an updated Wake County GIS layer. Work group members were asked to review the lists and determine if any critical facilities were missing or whether any were included on the list that should not be.

After this exercise was completed, Mr. Slaughter then discussed the key objectives of the mitigation strategy and identified goals that had been identified in past plans. The Atkins team had consolidated these goals into several overarching goals that were suggested to be the goals of the county-level plan. All participants were asked to make comments on the suggested goals and after minimal discussion, the goals were accepted.

Mr. Slaughter then explained that the Atkins team had also pulled all of the mitigation actions from previous mitigation plans into the same formatted table to enable consistency across the jurisdictions. He then provided copies to each jurisdiction of their specific mitigation action plan and demonstrated how the update process for these actions would be carried out. Mr. Slaughter asked each jurisdiction to provide status updates for each action and return them to him by the end of February 2013. He also provided a brief overview of how to include any new actions in the plan and provided some suggestions for actions that could be useful to implement in terms of mitigation.

In conclusion, Mr. Slaughter reminded the work group of the public outreach survey and asked them to publicize it as much as possible. The presentation ended with a discussion of the next steps to be taken in the project development, which included discussing data collection efforts, continuing public outreach, and the next meeting for the Coordinating Committee and Regional Work Groups.

The meeting was opened for questions and comments and only minor questions related to timeframes and follow up meetings were discussed.

The meeting was adjourned.

Meeting Minutes
Wake County Multi-Jurisdictional Hazard Mitigation Plan
West Wake Regional Work Group Meeting #1
December 13, 2013

Nathan Slaughter with Atkins, started the meeting by welcoming the representatives from the participating jurisdictions. Mr. Slaughter went on to discuss the purpose of the regional work groups which was to gain valuable input from local planners such as specific data and areas of risk.

Mr. Slaughter led the work group and began by providing an overview of the items to be discussed at the meeting and briefly reviewed each of the handouts that were distributed in the meeting packets (agenda and presentation slides). He then asked each of the meeting attendees to introduce themselves. Following introductions, he provided a brief overview of the stages of the mitigation planning process that would be addressed.

Ryan Wiedenman from Atkins then led the Risk Assessment discussion and explained the importance of identifying an accurate list of hazards that could potentially impact the jurisdictions. Mr. Wiedenman then presented a comprehensive list of hazards and led a discussion with the work group members until a list of hazards to be analyzed further was agreed upon.

Mr. Wiedenman then discussed the specific data needs for completing the risk assessment. Work group members were instructed to look into collecting building footprint and parcel data, as well as any local hazard studies that might have been carried out in the past. Mr. Wiedenman went on to explain the definition of critical facilities and how important they were to mitigation plans. This led to an exercise in which each local government representative was provided a list of critical facilities derived from both their current plans and an updated Wake County GIS layer. Work group members were asked to review the lists and determine if any critical facilities were missing or whether any were included on the list that should not be.

After this exercise was completed, Mr. Slaughter then discussed the key objectives of the mitigation strategy and identified goals that had been identified in past plans. The Atkins team had consolidated these goals into several overarching goals that were suggested to be the goals of the county-level plan. All participants were asked to make comments on the suggested goals and after minimal discussion, the goals were accepted.

Mr. Slaughter then explained that the Atkins team had also pulled all of the mitigation actions from previous mitigation plans into the same formatted table to enable consistency across the jurisdictions. He then provided copies to each jurisdiction of their specific mitigation action plan and demonstrated how the update process for these actions would be carried out. Mr. Slaughter asked each jurisdiction to provide status updates for each action and return them to him by the end of February 2013. He also provided a brief overview of how to include any new actions in the plan and provided some suggestions for actions that could be useful to implement in terms of mitigation.

In conclusion, Mr. Slaughter reminded the work group of the public outreach survey and asked them to publicize it as much as possible. The presentation ended with a discussion of the next steps to be taken in the project development, which included discussing data collection efforts, continuing public outreach, and the next meeting for the Coordinating Committee and Regional Work Groups.

The meeting was opened for questions and comments and only minor questions related to timeframes and follow up meetings were discussed.

The meeting was adjourned.

Meeting Minutes
Wake County Multi-Jurisdictional Hazard Mitigation Plan
East Wake Work Group Meeting #2
January 28, 2014

Nathan Slaughter, Project Manager from the project consultant, Atkins initiated the meeting by welcoming meeting attendees. He briefly explained the overall purpose of the meeting and briefly ran through the agenda items to be covered. He then asked meeting attendees to introduce themselves.

He provided a quick recap on how the regional work groups were set up and then provided a quick discussion of the project tasks involved with developing the hazard mitigation plan. He stated that the purpose of the meeting was to provide initial findings from the Risk Assessment and Capability Assessment and to start working on the Mitigation Strategy.

Ryan Wiedenman, a Planner with Atkins, then presented the findings of the risk assessment. He first discussed the major components of a Risk Assessment (Hazard Identification and Analysis and Vulnerability Assessment). He reviewed the Presidential Disaster Declarations that have impacted the County (13 events). He then explained the process for preparing Hazard Profiles and discussed how each hazard falls into one of four basic categories: Atmospheric, Hydrologic, Geologic, and Other. He indicated that each hazard must be evaluated and formally ruled out if it is not applicable to the study area, even where it seems obvious (such as in the case of volcano).

Mr. Wiedenman reviewed the Hazard Profiles and the following bullets summarize the information presented:

- DROUGHT. There have been eight years (out of the past fourteen, 2000-2013) where drought conditions have been reported as severe, extreme or exceptional in Wake County and future occurrences are likely.

- EXTREME HEAT. There have been 2 recorded extreme heat event reported since 1998 that resulted in one injury. Additional significant heat waves were reported in 1998, 2007, 2011 and 2012. Future occurrences are possible.

- HAILSTORM. There have been 261 recorded events since 1966. Future occurrences are likely.

- LIGHTNING. There have been 34 recorded lightning events since 1993, causing two deaths, and $3.4 million in reported property damages. Future occurrences are highly likely.

- TORNADOES. There have been 33 recorded tornado events reported in the county since 1950. $706.3 million in property damages. 7 deaths and 213 injuries have been reported. Future occurrences are likely.

- ♦ HURRICANES AND TROPICAL STORMS. NOAA data shows that 87 storm tracks have come within 75 miles of Wake County since 1850. 8 of these events were hurricanes, 55 were tropical storms and 24 were tropical depressions. Future occurrences are likely.

- ♦ THUNDERSTORM / HIGH WIND. There have been 351 severe thunderstorm events reported since 1958 with $1.2 million in reported property damages. 1 death and 6 injuries have been reported. Future occurrences are highly likely.

- ♦ WINTER STORM. There have been 28 recorded winter events in Wake County since 1993 resulting in $900,000 in reported property damages. Future occurrences are likely.

- ♦ EARTHQUAKES. There have been 13 recorded earthquake events in Wake County since 1886. The strongest had a recorded magnitude of VIII MMI. Future occurrences are possible.

- ♦ LANDSLIDE. There have been 11 recorded landslide events in Wake County. Future occurrences are possible.

- ♦ DAM FAILURE. There are 401 dams in Wake County, 144 of which are classified as high hazard dams. There have been 8 reported failures. Future occurrences are unlikely.

- ♦ EROSION. Erosion was included in some of the previous plans but impacts are minimal. Future occurrences are possible.

- ♦ FLOOD. There have been 100 flood events recorded in Wake County since 1995, resulting in $10.6 million in property damage. There have been 825 NFIP losses since 1978 and approximately $19.8 million in claims. 131 repetitive loss properties in the county account for 374 of the recorded losses. Future occurrences are likely.

- ♦ HAZARDOUS MATERIALS INCIDENTS. There have been 125 reported hazardous materials events reported in the county. Only 1 was reported as a serious incident. Future occurrences are likely.

- ♦ WILDFIRE. There is an average of 15.5 fires per year reported in Wake County. Future occurrences are likely but major events are not common.

- ♦ NUCLEAR ACCIDENT. There have been 33 minor historic nuclear events reported between the Shearon Harris and PULSTAR facilities. Future occurrences are unlikely.

- ♦ TERROR THREAT. There have been no historic terror events reported in Wake County. Future occurrences are unlikely although there are some potential targets in the County.

In concluding the review of Hazard Profiles, Mr. Wiedenman stated if anyone had additional information for the hazard profiles, or disagreed with any of the data presented, they should call or email him with their concerns.

The results of the hazard identification process were used to generate a Priority Risk Index (PRI), which categorizes and prioritizes potential hazards as high, moderate or low risk based on probability, impact, spatial extent, warning time, and duration. The highest PRI was assigned to Severe Thunderstorm/High

Wind, Hurricane/Tropical Storm, Tornado, Flood, and Nuclear Accident, followed by Drought, Extreme Heat, Hailstorm, Winter Storm/Freeze, HAZMAT Incident and Terror Threat. The Work Groups voted to move Nuclear Accident down to a moderate risk hazard.

Other general comments on the risk assessment from Work Group members are as follows:

- May need to revisit the erosion hazard as many of the jurisdictions have areas of localized erosion that pose a risk to infrastructure and/or structures.
- Terror threat is a great concern because there are 42 sites in Raleigh that are considered of high importance and potential targets of national significance.

Mr. Wiedenman then discussed Critical Facilities with the group. He stated what facilities were being included in the plan as being considered "critical". He stated that this listing differed from what some of the jurisdictions considered critical facilities in previous versions of their plans but that, a standardization of the listing was needed in order to be consistent with the analysis. He stated that "other" critical facilities could be provided and would be considered "secondary" critical facilities but would not be analyzed for vulnerability to hazards.

Mr. Slaughter presented the Capability Assessment Findings. Atkins has developed a scoring system that was used to rank the participating jurisdictions in terms of capability in four major areas (Planning and Regulatory; Administrative and Technical; Fiscal; Political). Important capability indicators include National Flood Insurance Program (NFIP) participation, Building Code Effective Grading Schedule (BCEGS) score, Community Rating System (CRS) participation, and the Local Capability Assessment Survey conducted by Atkins.

Mr. Slaughter reviewed the findings on which jurisdictions have the Relevant Plans and Ordinances, Relevant Staff/Personnel Resources, and Relevant Fiscal Resources. All of these categories were used to rate the overall capability of the participating counties and jurisdictions. All jurisdictions are in the high capability range for Planning and Regulatory Capability and most are in the moderate/high range for Fiscal Capability. Based upon the scoring methodology developed by Atkins, it was determined that all of the participating jurisdictions have at least moderate capability to implement hazard mitigation programs and activities and most fall into the high capability category.

Mr. Slaughter gave an overview of Mitigation Strategy Development. He reminded attendees that the goals for the plan were developed at the first Work Group meeting. He also reminded attendees that at the first Work Group meeting he asked them to start providing updates for the existing mitigation actions from old plans. He stated that he needed the updates provided by January 31. Finally Mr. Slaughter and Mr. Wiedenman discussed identification of new actions to include in the plan. Mr. Wiedenman presented specific mitigation actions to be considered by the Work Group members that were tailored specifically for their jurisdictions. The suggested actions were based on findings from the risk assessment and capability assessments.

Mr. Slaughter asked attendees to submit any new mitigation actions for the plan by email by February 28, 2014. He then reminded the Work Group members about the need to advertise the public survey for the plan. He stated that the survey had only 112 responses so far and that the survey would close on March 30. He then quickly reviewed the project schedule with the work group and then discussed next steps. The next steps included:

- Continuing public outreach
- Making adjustments to Risk Assessment (Atkins)
- Making adjustments to Capability Assessment (Atkins)
- Completing Jurisdiction-Specific Annexes (Atkins)
- Providing any New Mitigation Actions (Local Governments)
- Holding a Coordinating Committee Meeting (Atkins/TJCOG)

The being no questions and no other items for discussion, the meeting was adjourned.

Meeting Minutes
Wake County Multi-Jurisdictional Hazard Mitigation Plan
West Wake Work Group Meeting #2
January 31, 2014

Nathan Slaughter, Project Manager from the project consultant, Atkins initiated the meeting by welcoming meeting attendees. He briefly explained the overall purpose of the meeting and briefly ran through the agenda items to be covered. He then asked meeting attendees to introduce themselves.

He provided a quick recap on how the regional work groups were set up and then provided a quick discussion of the project tasks involved with developing the hazard mitigation plan. He stated that the purpose of the meeting was to provide initial findings from the Risk Assessment and Capability Assessment and to start working on the Mitigation Strategy.

Ryan Wiedenman, a Planner with Atkins, then presented the findings of the risk assessment. He first discussed the major components of a Risk Assessment (Hazard Identification and Analysis and Vulnerability Assessment). He reviewed the Presidential Disaster Declarations that have impacted the County (13 events). He then explained the process for preparing Hazard Profiles and discussed how each hazard falls into one of four basic categories: Atmospheric, Hydrologic, Geologic, and Other. He indicated that each hazard must be evaluated and formally ruled out if it is not applicable to the study area, even where it seems obvious (such as in the case of volcano).

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- May need to revisit the erosion hazard as many of the jurisdictions have areas of localized erosion that pose a risk to infrastructure and/or structures.
- Terror threat is a great concern because there are 42 sites in Raleigh that are considered of high importance and potential targets of national significance.

Mr. Wiedenman then discussed Critical Facilities with the group. He stated what facilities were being included in the plan as being considered "critical". He stated that this listing differed from what some of the jurisdictions considered critical facilities in previous versions of their plans but that, a standardization of the listing was needed in order to be consistent with the analysis. He stated that "other" critical facilities could be provided and would be considered "secondary" critical facilities but would not be analyzed for vulnerability to hazards.

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- Making adjustments to Capability Assessment (Atkins)
- Completing Jurisdiction-Specific Annexes (Atkins)
- Providing any New Mitigation Actions (Local Governments)
- Holding a Coordinating Committee Meeting (Atkins/TJCOG)

The being no questions and no other items for discussion, the meeting was adjourned.

Meeting Minutes
Wake County Multi-Jurisdictional Hazard Mitigation Plan
Coordinating Committee Meeting #1
April 1, 2014

Nathan Slaughter, Project Manager from the project consultant Atkins, started the meeting by welcoming the attendees and explaining the purpose of the group, which is to provide input on the Wake County Multi-Jurisdictional Mitigation Plan. Sarah Bruce with Triangle J Council of Governments explained that participants for this advisory committee had been identified through an extensive process of contacting various groups, including groups serving disabled populations, Spanish speakers, and businesses.

Mr. Slaughter led the meeting and began by providing an overview of the agenda items and briefly reviewed each of the handouts that were distributed in the meeting packets (agenda and presentation slides). He then asked each of the meeting attendees to introduce themselves. Following introductions, he provided a brief overview of the meeting agenda and the stages of the mitigation planning process that would be addressed through this plan.

He emphasized that mitigation refers to actions (projects, policies, plans) to reduce the impacts of future hazard events. The hazard mitigation planning process looks at hazards, capability to conduct mitigation, and specific activities to reduce impacts of hazards. He stressed that a mitigation plan is not a response plan.

He explained how Federal legislation requires local governments to have a hazard mitigation plan in place to remain eligible for federal mitigation grants (e.g., HMGP, FMAP, PDM). So, there is funding to implement some of the actions that this plan may identify. North Carolina also has NC Senate Bill 300 that requires mitigation plans be in place in order to receive state recovery funds. The State (NC Emergency Management) is encouraging local governments to do multijurisdictional planning, which helps everything be more efficient and coordinated.

He explained to the group that all local governments in Wake County already have a mitigation plan. They expire at different times, but they all will be on the same schedule after this plan is completed. Atkins is in the process of pulling out and updating relevant information from existing plans. The project schedule estimates 6 months for compiling and updating the plan and 6 months for plan review and adoption.

He explained that there are two Regional Work Groups (eastern and western Wake), which have been working through the steps in the planning process for their respective areas:

1. Identify and analyze hazards, risk assessment
2. Capability assessment (of local governments)
3. Mitigation Strategy – specific activities to reduce future impacts
4. Documentation and maintenance

Risk Assessment
Mr. Slaughter explained that FEMA requires that plans address natural hazards, but all-hazards approach is becoming more prevalent. Some manmade/technological hazards have been included in the hazard identification, but vulnerability assessment focuses more on the natural hazards since more mitigation funding is available for natural hazards. Mr. Slaughter presented the list of hazards to be addressed in the plan. He explained that the initial list of hazards was approved by both of the regional Work Groups.

The Coordinating Committee made the following suggestions regarding the Hazard Identification:

- Consider adding additional hazard: **Infrastructure Failure**
    - Power grid failure
    - Fiber line cut
    - Water system failure

  NC has a State Energy Assurance Plan that covers gas pipelines and power grid failures, but it might not be specific to Wake County. Duration of failure is important. Shortages may also cause impacts.

- Consider adding additional hazard: **Financial system collapse/Oil supply disruption/Civil unrest**

Consider how to manage impacts of these, even if there is nothing we can do to prevent them.

- Consider rephrasing: **Terror threat to terror impact**

This terminology should be more specific to the actual action/problem. The impact of a terrorist event is the hazard, not the "threat".

- Consider adding additional hazard: **Transportation system incident**

Airport and train lines accidents might be hazmat related, but impacts would not necessarily be related to hazmat.

- Regarding **Geological subsidence:** Fracking-related subsidence might be something to consider in the future.

- Consider adding additional hazard: **Asteroids**

NC used to have asteroids in state plan; FEMA said revisit and remove, but it has happened (Russia last year)

- Consider adding additional hazard: **Insect-borne illnesses/pandemics**

West Nile is an example of this hazard.

The group also discussed **nuclear accidents** (there is a nuclear bomb in Goldsboro; NCSU has a nuclear power plant, as well as Shearon Harris. Hospitals have to control Cesium tablets.)

The group also discussed synchronous/cascading events. The probability of future occurrences is considered in isolation, but cascading effects are considered in the plan. Consider enhancing language on probability vs "500-year event" to be clear that hazards don't observe the frequency that might be used as a shorthand for statistical probability.

Capability Assessment

Mr. Slaughter explained the community capability assessment and discussed how capability is divided primarily into 3 categories:

- Administrative
- Technical
- Fiscal

Mr. Slaughter explained that results from the capability assessment indicate that capability to implement mitigation measures in Wake County is pretty high compared to the rest of the country.

Mitigation Strategy

Mr. Slaughter discussed the six mitigation techniques and then presented the mitigation goals for the plan. He explained that the existing plans all have separate goals, which were the basis for the draft goals for the multijurisdictional plan. He then explained how each existing plan included mitigation actions, which have been compiled as a starting point, and jurisdictions have been asked to update these.

Public Involvement
Mr. Slaughter explained how public comment and participation is a required part of this process. A public survey was developed and extensively disseminated, to which approximately 500 responses were received. WRAL also ran a story on the plan update process.

The group suggested posting the draft plan for public comment to

- RTP Foundation and Chamber
- Senior living centers, day centers
- Large employers
- Local governments (newsletters?)
- Public libraries
- Utility mailings (Duke, CORPUD)

Ms. Bruce gave an update on the wiki (project website). She explained how to join the wiki and post comments there or just email them to Sarah and Nathan. The wiki will still allow staff to share files with the group without having to use email attachments.

There being no other questions or topics of discussion, the meeting was adjourned.

Wake County Multi-Jurisdictional Hazard Mitigation Plan
Project Kickoff Meeting

November 21, 2013
10:00 AM - Noon

Name	Agency	City	Phone Number	E-mail Address
Leslie O'Connor	Fire Dept.	Cary	919-624-4447	leslieoconnor2013@gmail.com
Brad Robinson	Fire Dept	Cary	919-676-3198	rescue40K@yahoo.com
Chris Lukasina	CAMPO		919-996-4400	chris.lukasina@campo-nc.us
Jeff Jones	Town of Holly Springs	Holly Springs	919 557-3908	jeff.jones@hollyspringsnc.us
Tim Maloney	Wake County		919-856-6678	tmaloney@wakegov.com
Josh Creighton	Wake Co		9198566485	joshua.creighton@wakegov.com

Wake County Multi-Jurisdictional Hazard Mitigation Plan
Project Kickoff Meeting

November 21, 2013
10:00 AM - Noon

Name	Agency	City	Phone Number	E-mail Address
Tom Birkland	NC State U	Raleigh	919-513-1834	tabirkla@ncsu.edu
TJ Cawley	Morrisville Council	Morrisville	9195399683	TJCawley@hotmail.com
Patrick Reidy	Town of Wendell	Wendell	919-365-4448	preidy@townofwendell.com
Brian Bulla	NCSU	Raleigh		bzbulla@ncsu.edu
Emily B McCartha	NCSU	Raleigh		ebmccart@ncsu.edu
Lisa Booze	City of Raleigh	Raleigh		lisa.booze@raleighnc.gov
Thomas Lloyd	Town of Rolesville	Rolesville	919.554.6517	thomas.lloyd@rolesvillenc.gov
Charles Brown	Town of Cary	Cary	919-469-4038	charles.brown@townofcary.org

Wake County Multi-Jurisdictional Hazard Mitigation Plan
Project Kickoff Meeting

November 21, 2013
10:00 AM - Noon

Name	Agency	City	Phone Number	E-mail Address
Kenneth Withrow	NC Capital Area MPO	Raleigh	(919) 996-4394	kenneth.withrow@campo-nc.us
LOUIS HUFHAM	RESIDENT + STUDENT	KNIGHTDALE	(919) 217-6118	hufham4@bellsouth.net
Sarah DeYoung	North Carolina State University	Raleigh	(919) 760-9229	sedeyoun@ncsu.edu
MICHAEL COOPER	CARY FIRE DEPT	CARY	919 469-4378	mike.cooper@townofcary.org
Samantha Smith	Town of Fuquay-Varina	→	919 552 1421	ssmith@fuquay-varina.org
Jack Moyer	URS	morrisville	919-461-1472	jack.moyer@urs.com
Mark Hetrick	Town of Zebulon		919-823-1808	mhetrick@townofzebulon.nc
Daniel Weeks	Holly Springs →		919-557-2924	daniel.weeks@hollyspringsnc.us

Wake County Multi-Jurisdictional Hazard Mitigation Plan
Project Kickoff Meeting

November 21, 2013
10:00 AM - Noon

Name	Agency	City	Phone Number	E-mail Address
Billy Lee	Town of Cary	Cary	919 462 3932	Billy.lee@townofcary.org
Monte Matthews	US Army Corps/Engineers	Raleigh	919 846 9332	Monte.k.matthews@usace.army.mil
Travis Williams	SEBTS	Wake Forest	(919) 761-2422	twilliams@sebts.edu
MICHAEL LAWSON	SEBTS	WAKE FOREST	919.761.2103	MLAWSON@SEBTS.EDU
Toy Beeninga	NC State	Raleigh	336-681-3825	tsbeenin@ncsu.edu
June Cowles	Apex	Apex	919 249 3331	june.cowles@apexnc.org
Will Brown	Apex	Apex	919-249-3336	will.brown@apexnc.org
Courtney Tanner	Morrisville	Morrisville	919-463-6199	ctanner@townofmorrisville.org
Jeff Triezenberg	Knightdale	K-dale	919-217-2245	jeff.triezenberg@knightdalenc.gov

Wake County Multi-Jurisdictional Hazard Mitigation Plan
Project Kickoff Meeting

November 21, 2013
10:00 AM - Noon

Name	Agency	City	Phone Number	E-mail Address
Jaclyn Rametta	Town of Garner	Garner	919-773-4421	JRAMETTA@garnernc.gov
Kim Brennan	CRC	Apex	919-637-1940	kbrennan@callcrc.com
Agnes Wanman	Town of Wake Forest Planning	Wake Forest	919-435-9516	awanman@wakeforestnc.gov
Robert Greer	citizen	Garner	919-772-7740	rgreer2@nc.rr.com

Wake County Multi-Jurisdictional Hazard Mitigation Plan
Eastern Wake Work Group Meeting

December 12, 2013
10:00 AM - Noon

Name	Agency	City	Phone Number	E-mail Address
Agnes Wanman	Plng. Dept ~~Town of Wake Forest~~	Wake Forest	919-435-9516	awanman@wakeforestnc.gov
Tim Maloney	Wake Co. Planning		919-856-6678	tmaloney@wakegov.com
Thomas Lloyd	Rolesville Planning	Rolesville	919-556-3506	thomas.lloyd@rolesvillenc.gov
Julie Spriggs	Zebulon	Zebulon	919 823 1809	jspriggs@townofzebulon.org
Charlie Yokley	TOWF Planning	Wake Forest	919-435-9517	cyokley@wakeforestnc.gov
Tim Guffey	Knightdale Fire	Knightdale	919-217-2270	tim.guffey@knightdalenc.gov
Fred Boone	TOK	"	919-217-2250	Fred.boone@knightdalenc.gov

Wake County Multi-Jurisdictional Hazard Mitigation Plan
Eastern Wake Work Group Meeting

December 12, 2013
10:00 AM - Noon

Name	Agency	City	Phone Number	E-mail Address
JEFF TRIEZENBERG	TOWN OF KNIGHTDALE	"	919-217-2245	jeff.triezenberg@knightdalenc.gov
Zumilda Rodriguez	Town of Wendell	"	919-365-4458	~~Zrodr~~ zrodriguez@townofwendell.com
Patrick Reidy	Town of Wendell	"	" "	preidy@townofwendell.com

Wake County Multi-Jurisdictional Hazard Mitigation Plan
Western Wake Work Group Meeting

December 13, 2013
10:00 AM - Noon

Name	Agency	City	Phone Number	E-mail Address
Chuck Queen	Town of Morrisville	Morrisville	919-463-7121	cqueen @ townofmorrisville.org
Jeff Jones	Town of Holly Springs	Holly Springs	919-557-3908	jeff.jones@ HollySpringsnc.us
Daniel Weeks	"	"	919-557-2924	daniel.weeks@ hollyspringsnc.us
Mary Beerman	Town of Cary	Cary	919 - 469-4342	mary.beerman @ townofcary.org
DERRICK REMER	CITY OF RALEIGH	RALEIGH	919-996-4157	derrick.remer@ raleighnc.gov
Samantha Smith	Town of Fuquay Varina	—	919 552 1421	ssmith@ fuquay-varina.org
June Cowles	Town of Apex	Apex	919-249-3331	june.cowles @ apexnc.org
Charles Brown	Town of Cary	Cary	919-469-4038	charles.brown@ townofcary.org

Wake County Multi-Jurisdictional Hazard Mitigation Plan
Western Wake Work Group Meeting

December 13, 2013
10:00 AM - Noon

Name	Agency	City	Phone Number	E-mail Address
SHARON PETERSON	WAKE COUNTY PLANNING	County	919 856-6325	sharon.peterson@ wakegov.com

Wake County Multi-Jurisdictional Hazard Mitigation Plan
Eastern Wake Work Group Meeting

January 28, 2014
10:00 AM - Noon

Name	Agency	City	Phone Number	E-mail Address
Sarah Bruce	TJCOG	RTP/Durham	919-558-9343	sbruce@tjcog.org
Julie Spriggs	Town of Zebulon	Zebulon	919 823 1809	jspriggs@townofzebulon.org
Jeff Triezenberg	Town of Knightdale	Knightdale	919-217-2245	jeff.triezenberg@knightdalenc.gov
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Wake County Multi-Jurisdictional Hazard Mitigation Plan
Western Wake Work Group Meeting

January 31, 2014
10:00 AM - Noon

Name	Agency	City	Phone Number	E-mail Address
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Wake County Multi-Jurisdictional Hazard Mitigation Plan
Western Wake Work Group Meeting

January 31, 2014
10:00 AM - Noon

Name	Agency	City	Phone Number	E-mail Address
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Wake County Hazard Mitigation Plan Coordinating Committee
April 1, 2014

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Wake County Multi-Jurisdictional Hazard Mitigation Plan
Final Public Meeting

December 30, 2014

6:00 PM

Name	Address	City	Phone Number	E-mail Address
DERRICK REMER	222 W. HARGETT ST	RALEIGH	919-996-4657	DERRICK.REMER@RALEIGHNC.GOV
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Appendix E
Community Rating System

This section of the Plan provides a summary of mitigation measures that were considered by the participating jurisdictions in Wake County to reduce their risk to the flood hazard specifically, thereby achieving the requirements set forth in Section 510 of the Community Rating System (specifically Step 7). These flood mitigation measures are based on suggested activities that have been shown to significantly reduce flood risk and have been analyzed by each of the respective communities that participate in the Wake County Hazard Mitigation Plan. The measures are broken down into one of the following six categories of activities that fall within the sphere of prevention activities:

PREVENTION ACTIVITIES

- Floodplain Management
- Comprehensive or Land Use Planning
- Zoning
- Subdivision Regulations
- Stormwater Management
- Building Codes

E.1 INTRODUCTION

This appendix to the Hazard Mitigation Plan was developed in order to enhance each jurisdiction's overall resilience to the flood hazard by documenting the steps taken, and those that need to be taken to help improve each jurisdiction's regulatory environment through preventative actions. In order to maximize points that can be awarded to reduce flood insurance rates through the Community Rating System, communities must thoroughly evaluate preventative mitigation measures.

These measures are often considered the most exemplary type of mitigation actions that can be implemented because their purpose is to prevent issues related to flooding from occurring at all. For instance, if a community were to prohibit any construction within the floodplain, this would prevent any structures that might have been built in that area from being flooded because they won't be located in a high risk area.

Preventative measures are often associated with planning and regulatory activities such as zoning and building codes. The six main categories of prevention activities are outlined above and each of these types of activities are assessed in greater detail below. For each community that participated in this plan, an evaluation of several measures for each category was carried out to determine the community's willingness to implement preventative measures and outline a plan for reducing flood risk.

Within this evaluation, current standards and regulations are identified along with an explanation of local implementation of the specific standard or regulation. In addition, recommendations for future implementation have been discussed and any changes that were considered but discounted as not feasible have been identified along with an explanation concerning why that determination was made.

E.1.1 Floodplain Management

Floodplain Management is a broad category that generally overlaps many of the other prevention-related categories identified herein. However, while other categories of prevention activities such as zoning often exist for purposes beyond mitigation and risk reduction, floodplain management is the primary activity designed to reduce flood risk. Each of the jurisdictions that participated in the hazard mitigation planning process considered several activities that attempt to reduce flood risk through better management of identified floodplain areas.

As described in **Table E.1**, in some cases, it was determined that local governments were already implementing risk reducing activities and merely needed to formalize their commitment to continue to enact these measures. In general, communities were either already implementing floodplain management activities or were working towards implementing these activities in the near future. However, some activities that were considered for implementation could not be incorporated into the local government's implementation structure. In cases where activities were considered, but could not be moved forward, the activity has been identified and an explanation of why it would not be feasible has been included.

TABLE E.1: FLOODPLAIN MANAGEMENT ACTIVITIES

Preventative Activities				
Floodplain Management Regulations— There are a number of regulations that a local government can put into place that can be considered under the category of floodplain management regulations. For example, a jurisdiction could adopt a flood damage prevention ordinance, develop a floodplain management plan, or participate in the National Flood Insurance Program. Each of these activities may help reduce the impact of flooding by providing regulatory guidance aimed at the specific areas within the jurisdiction that are most vulnerable to flooding. Floodplain management regulations are an appropriate activity that Wake County and its municipalities can use to reduce future flood losses since each community has some type of floodplain management regulation in place.				
Jurisdiction	**Current Standards/ Regulations**	**Local Implementation**	**Recommendations for Future Implementation**	**Changes Considered but Discounted as Not Feasible**
Wake County	UDO, Article 14: Flood Hazard Areas	The Wake County Flood Hazard Management Ordinance includes a number of requirements for submitting a permit prior to any construction in areas designated as a floodplain. For example, base flood elevation must be provided with the permit application and development within the floodway is heavily restricted.	• The county should continue to implement its higher freeboard requirements for properties located in the floodplain • The county should continue to prohibit any fill in floodplain areas. • The county should continue to implement its "no-rise" in base flood elevation clause.	• The county has considered a number of options regarding floodplain management regulations as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Apex	UDO, Article 6.2: Flood Damage Prevention Overlay District	The Apex UDO includes an article that establishes a flood damage prevention overlay district in which new development is essentially not allowed.	• The town is willing to consider possibly implementing higher freeboard requirements for properties located in the floodplain • The town is willing to consider possibly establishing a provision that prohibits any fill in floodplain areas.	• The town considered adopting a "no-rise" in base flood elevation clause, but it was determined to be not politically or economically feasible.
Cary	LDO, Chapter 7.5: Flood Damage Prevention	The Cary LDO includes provisions that state that, in general, no development is allowed in flood hazard areas or future condition flood hazard areas. The few exceptions to this restriction are related to special uses, greenways, and public utilities.	• The town should continue to implement its higher freeboard requirements for properties located in the floodplain • The town should continue to implement its "no-rise" in base flood elevation clause	• The town has considered prohibiting any fill in floodplain areas but it was determined to be not legally feasible
Fuquay-Varina	Flood Response Plan; Flood Damage Prevention Ordinance	Fuquay-Varina's Flood Damage Prevention Ordinance includes a number of requirements for submitting a permit prior to any construction in areas designated as a floodplain, such as the submission of a map with the floodplain clearly delineated. Fuquay-Varina also has a flood response plan for secondary roads and Town streets that are prone to flood in certain storm events. Involves installing barricades, detours, and monitoring each location to determine when it is safe to maneuver across a street.	• The town should continue to maintain its higher freeboard requirements for properties located in the floodplain • The town should continue to implement its "no rise" in base flood elevation clause • The town is willing to consider possibly establishing a provision that prohibits any fill in floodplain areas	• The town has considered a number of options regarding floodplain management regulations as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Garner	UDO, Article 7.2.H: Floodplain Management	Garner's UDO explains that town regulations specifically prohibit development in the 100 year floodplain and in conservation or protected buffers except in a very limited area specifically identified in the UDO.	• The town should continue to maintain its higher freeboard requirements for properties located in the floodplain • The town is willing to consider possibly prohibiting any fill in floodplain areas • The town should continue to implement its "no-rise" in base flood elevation clause	• The town has considered a number of options regarding floodplain management regulations as is evident in previous columns. It is at least considering implementation of all options that were considered.
Holly Springs	Flood Damage Prevention Ordinance	In its code, Holly Springs includes a FDPO which defines standards related to development within the floodplain. These standards require that any new construction have the reference level elevated no lower than the regulatory flood protection elevation and further states that no fill shall be place in the floodplain for the purpose of providing a buildable area. The town also requires a two-foot freeboard for development located in the floodplain.	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning
Knightdale	UDO, Ch. 6.6: Flood Damage Prevention	Knightdale's UDO includes a FDPO which outlines a number of requirements concerning development in the floodplain. For example, new residential construction or substantial improvement of such structure is required to have a reference level no lower than two feet above the base flood elevation.	• The town should continue to maintain its higher freeboard requirements for properties located in the floodplain • The town is willing to consider possibly prohibiting any fill in floodplain areas • The town should continue to implement its "no-rise" in base flood elevation clause	• The town has considered a number of options regarding floodplain management regulations as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Morrisville	Flood Damage Prevention Ordinance	Morrisville's Flood Damage Prevention Ordinance sets a requirement that any new residential construction shall have the reference level elevated no lower than the regulatory flood protection elevation. The town also requires a two-foot freeboard for development located in the floodplain.	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning
Raleigh	UDO, Article 9.3: Floodprone Areas Regulations	Raleigh's UDO lays out restrictions on development in the floodway including that structures shall be located outside the floodway area and that any structure that overhangs the floodway is elevated about the depth of the 500 year flood.	• The city should continue to maintain implement higher freeboard requirements for properties located in the floodplain • The city should continue to prohibit fill in floodplain areas • The city is willing to consider possibly adopting a "no-rise" in base flood elevation clause	• The city has considered a number of options regarding floodplain management regulations as is evident in previous columns. It is at least considering implementation of all options that were considered.
Rolesville	UDO, Chapter 7.2: Flood Damage Prevention Standards	Rolesville's UDO includes standards for flood damage prevention such as requirements for documentation during the permitting process. For example, the permit application must include mapping of the floodplain or future conditions floodplain and reference level elevation.	• The town should continue to implement its higher freeboard requirements for properties located in the floodplain • The town should continue to prohibit any fill in the floodplain areas • The town should continue to implement its "no-rise" in base flood elevation clause	• The town has considered a number of options regarding floodplain management regulations as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Wake Forest	UDO, Article 12.4: Flood Damage Prevention	In Wake Forest's UDO, there are standards for new construction or substantial improvements that require the reference level to be elevated no lower than the regulatory flood protection elevation.	• The town should continue to implement higher freeboard requirements for properties located in the floodplain • The town should continue to prohibit any fill in floodplain areas • The town should continue to implement its "no-rise" in base flood elevation clause	• The town has considered a number of options regarding floodplain management regulations as is evident in previous columns. It is at least considering implementation of all options that were considered.
Wendell	UDO, Chapter 6.7: Flood Damage Protection Ordinance	Wendell's Flood Damage Prevention Ordinance states that no development or redevelopment is permitted in the flood hazard or buffer zones with the exception of some uses like greenways, parks, or stabilization efforts. All these activities must minimize impervious coverage.	• The town should continue to implement higher freeboard requirements for properties located in the floodplain • The town should continue to prohibit any fill in floodplain areas • The town is willing to consider possibly adopting a "no-rise" in base flood elevation clause	• The town has considered a number of options regarding floodplain management regulations as is evident in previous columns. It is at least considering implementation of all options that were considered.
Zebulon	Flood Damage Prevention Code (Code of Ordinances Ch. 151)	Within Zebulon's stormwater management regulations, there are some provisions that are related to flood damage prevention.	• The town should continue to maintain its higher freeboard requirements for properties located in the floodplain • The town should continue to prohibit any fill in floodplain areas • The town should continue to implement its "no rise" in base flood elevation clause	• The town has considered a number of options regarding floodplain management regulations as is evident in previous columns. It is at least considering implementation of all options that were considered.

E.1.2 Comprehensive or Land Use Planning

Comprehensive or Land Use Planning is one of the most impactful means of reducing flood risk because it can provide an overall plan for the community in terms of where development takes place. As a result, comprehensive/land use planning can help direct people and property out of known flood prone areas and reduce the threat of future flood losses. Each of the jurisdictions that participated in the Hazard Mitigation Planning process considered several activities that attempt to reduce flood risk through better either a comprehensive or land use plan.

As described in **Table E.2**, in some cases, it was determined that local governments were already implementing risk reducing activities and merely needed to formalize their commitment to continue to enact these measures. In general, communities were either already implementing comprehensive or land use planning activities or were working towards implementing these activities in the near future. However, some activities that were considered for implementation could not be incorporated into the local government's implementation structure. In cases where activities were considered, but could not be moved forward, the activity has been identified and an explanation of why it would not be feasible has been included.

TABLE E.2: COMPREHENSIVE/LAND USE PLANNING ACTIVITIES

Preventative Activities

Comprehensive/Land Use Plan— A comprehensive land use plan establishes the overall vision for what a community wants to be and serves as a guide for future governmental decision making. Typically a comprehensive plan contains sections on demographic conditions, land use, transportation elements, and community facilities. Given the broad nature of the plan and its regulatory standing in many communities, the integration of hazard mitigation measures into the comprehensive plan can enhance the likelihood of achieving risk reduction goals, objectives, and actions. For example, the comprehensive plan can help reduce future flood risk by including a policy to prohibit new development within the 100-year floodplain or by including a goal to maximize open space in the floodplain. Comprehensive planning is an appropriate activity that Wake County and its municipalities can use to reduce future flood losses since each community already has a comprehensive plan in place.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Wake County	Wake County Land Use Plan	The Wake County Land Use Plan includes a section on water shed protection policies which includes policies to limit development in watershed areas. Specific policies include drainageway buffers and impervious surface coverage limits, both of which allow water to take its natural course into the ground, thereby reducing flood risk.	• The county is willing to consider possibly increasing the amount of its land area classified as open space. • The county is willing to consider possibly preventing infrastructure expansion in areas exposed to flood hazards.	• The county considered classifying all areas delineated as floodplain as open space but it was determined to be not socially feasible.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Apex	Peak Plan 2030 Comprehensive Plan, Growth Management Plan	Peak Plan 2030 identifies the use of green building techniques, such as rainwater capture systems in new developments, as an important component of future growth. It also encourages low impact site development and more sustainable landscapes. These techniques have been shown to reduce the risk of flooding and flood losses by managing excess water runoff.	• The town is willing to consider possibly increasing the amount of its land area that is classified as open space. • The town should continue to prevent infrastructure expansion in areas exposed to flood hazard	• The town considered classifying all areas delineated as floodplain as open space but it was determined to be not politically or economically feasible.
Cary	Comprehensive Plan, Land Use Plan, Growth Management Plan	The Cary Comprehensive Plan recognizes the importance of floodplain management and explains how the town places severe restrictions on development within the 100 year floodplain which helps to reduce the number of people and property that would otherwise be directly exposed to flooding.	• The town is willing to consider possibly increasing the amount of its land area that is classified as open space. • The town should continue to classify all areas delineated as floodplain as open space	• The town considered preventing infrastructure expansion in areas exposed to flood hazards but it was determined to be not administratively feasible
Fuquay-Varina	Comprehensive Growth Management Plan; Land Use Plan	Fuquay-Varina's land use plan includes provisions for areas of parks and open space as well as for significant natural resources and greenways. These area types help reduce flood losses and flood risk by reducing impermeable surface areas and allowing water to naturally flow into the groundwater supply.	• The town has increased the amount of its land area classified as open space and should continue to work to increase this amount. • The town has classified many floodplain areas as open space and should continue to work to do so • The town is willing to consider possibly establishing a provision that prevents infrastructure expansion in areas expose to flood hazards.	• The town considered classifying all floodplain areas as open space and although many floodplain areas are designated as such, it was not socially feasible to designate all floodplains as open space.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Garner	Comprehensive Growth Plan	Garner's Comprehensive Plan includes the identification of undeveloped lands to be used as parkland or open space preservation. This can reduce the risk of flood by reducing the amount of impermeable surface area in the town and allowing the natural flow of water.	• The town is willing to consider possibly increasing the amount of its land area classified as open space. • The town is willing to consider possibly classifying all areas delineated as floodplain as open space • The town is willing to consider possibly preventing infrastructure expansion in areas exposed to flood hazards.	• The town has considered a number of options regarding comprehensive planning as is evident in previous columns. It is at least considering implementation of all options that were considered.
Holly Springs	Vision Holly Springs Comprehensive Plan	Holly Springs identifies a number of areas in the jurisdiction that will be preserved as conservation areas. These areas can dramatically reduce the amount of flood losses a community experiences by allowing the ground to absorb water and reintegrate it into natural storage areas.	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning
Knightdale	2027 Comprehensive Plan	The town's comprehensive plan discusses a number of areas within the jurisdiction that have been preserved as parks or greenway systems. These areas help to increase the permeable surface area within the town and allow flood waters to take their natural course, thereby reducing flood losses.	• The town has increased the amount of its land area classified as open space and should continue to work to increase this amount.	• The town considered delineating all areas delineated as floodplain as open space but it was determined to not be administratively or legally feasible • The town considered preventing infrastructure expansion in areas exposed to flood hazards but it was determined to not be socially, politically, or economically feasible

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Morrisville	Land Use Plan	The land use plan includes an analysis of current development conditions and identifies areas of future growth. This can help preserve areas of open space and promote recreation zones. In general, the plan promotes policies oriented towards reducing impermeable surface and increasing parks and green areas with residential development, all of which aid the natural flow and recharge of water, thereby reducing risk.	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning
Raleigh	2030 Comprehensive Plan	Raleigh's Comprehensive plan outlines a number of policies that have the effect of reducing flood risk and losses including the preservation of natural watercourses, low impact development to mitigate the impact of stormwater runoff, as well as rain gardens, cisterns, and rain barrels. The plan also focuses on watershed level planning and protecting open space. These strategies can have a significant impact on water retention and management, which reduces risk.	• The city is willing to consider possibly increasing the amount of its land area classified as open space • The city is willing to consider possibly preventing infrastructure expansion in areas exposed to flood hazards	• The city considered classifying all areas delineated as floodplain as open space, but it was determined to not be administratively, legally, or politically feasible

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Rolesville	Rolesville Community Plan (2007)	Rolesville's Community plan addresses the link between open space preservation and citizen health/safety as it seeks to require the creation of greenways along designated stream corridors as a condition of development within the town. This would help reduce risk by limiting development in the highest flood prone areas.	• The town is willing to consider possibly increasing the amount of its land area classified as open space • The town is willing to consider classifying all areas delineated as floodplain as open space • The town is willing to consider possibly preventing infrastructure expansion in areas exposed to flood hazards	• The town has considered a number of options regarding its comprehensive plan as is evident in previous columns. It is at least considering implementation of all options that were considered.
Wake Forest	Wake Forest Community Plan	The town's Community Plan emphasizes the importance of planning for water quality and including low impact development in the town's future. Among other strategies, the plan highlights on-site stormwater retention, natural runoff and drainage systems, and riparian buffers to reduce the impact of development and create a safer community.	• The town is willing to consider possibly increasing the amount of its land area classified as open space • The town should continue to classify all areas delineated as floodplain as open space • The town is willing to consider possibly preventing infrastructure expansion in areas exposed to flood hazards	• The town has considered a number of options regarding its comprehensive plan as is evident in previous columns. It is at least considering implementation of all options that were considered.
Wendell	Comprehensive Plan (2007)	The town's Comprehensive Plan includes a designation for preserved open space that is intended to protect wetlands and water bodies, including the Neuse River which is regulated by a minimum 50 feet of vegetative buffer on either side. This can help reduce people and property that are directly exposed to flooding.	• The town is willing to consider possibly increasing the amount of its land area classified as open space • The town is willing to consider possibly classifying all areas delineated as floodplain as open space	• The town considered preventing infrastructure expansion in areas exposed to flood hazards but it was determined to be not economically feasible

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Zebulon	2010 Comprehensive Development Plan	Zebulon includes goals in its Comprehensive Plan that emphasize the importance of protecting wetlands, stream corridors, and floodplains and goes on to explain that future development should be carried out in a sustainable manner. This can help by allowing the natural flow of water back into the system.	• The town is willing to consider possibly increasing the amount of its land area classified as open space • The town is willing to consider possibly classifying all areas delineated as floodplain as open space • The town should continue to prevent infrastructure expansion in areas exposed to flood hazards	• The town has considered a number of options regarding its comprehensive plan as is evident in previous columns. It is at least considering implementation of all options that were considered.

E.1.3 Zoning

Zoning is often considered an arm of land use planning and is generally designed to regulate certain functions or characteristics of development that are allowed in an area of the jurisdiction. Much like land use planning, zoning can help direct development outside of high risk areas and also regulate the density of development that is allowed in those areas. Each of the jurisdictions that participated in the Hazard Mitigation Planning process considered several activities that attempt to reduce flood risk through some form of zoning.

As described in **Table E.3**, in some cases, it was determined that local governments were already implementing risk reducing activities and merely needed to formalize their commitment to continue to enact these measures. In general, communities were either already implementing zoning activities or were working towards implementing these activities in the near future. However, some activities that were considered for implementation could not be incorporated into the local government's implementation structure. In cases where activities were considered, but could not be moved forward, the activity has been identified and an explanation of why it would not be feasible has been included.

TABLE E.3: ZONING ACTIVITIES

Preventative Activities				
Zoning— Zoning represents the primary means by which land use is controlled by local governments. As part of a community's police power, zoning is used to protect the public health, safety, and welfare of those in a given jurisdiction that maintains zoning authority. A zoning ordinance is the mechanism through which zoning is typically implemented. Since zoning regulations enable municipal governments to limit the type and density of development, a zoning ordinance can serve as a powerful tool when applied in identified hazard areas. For example, the comprehensive plan can help reduce future flood risk by prohibit or limit future construction in the 100-year floodplain or by limiting the density of development in the floodplain. Zoning is an appropriate activity that Wake County and its municipalities can use to reduce future flood losses since each community has some degree of zoning in place.				
Jurisdiction	**Current Standards/ Regulations**	**Local Implementation**	**Recommendations for Future Implementation**	**Changes Considered but Discounted as Not Feasible**
Wake County	UDO, Article 3: Zoning Districts. Zoning regulations are not applicable to the jurisdictions of the incorporated municipalities.	The Wake County Land Use Plan includes a section on water shed protection policies which includes policies to limit development in watershed areas. Specific policies include drainageway buffers and impervious surface coverage limits, both of which allow water to take its natural course into the ground, thereby reducing flood risk.	• The county should continue to prohibit or limit future construction in the floodplain • The county should continue to limit the density of development in the floodplain	• The county considered requiring a higher ration than is currently in place of permeable to impermeable surface area in new commercial construction, but it was determined to not be politically feasible
Apex	UDO, Article 3: Zoning Districts.	Article 3 of the Apex UDO specifically identifies a flood damage prevention overlay district that is intended to minimize public and private losses due to flood conditions.	• The town is willing to consider possibly requiring a higher ratio of permeable to impermeable surface area in new commercial construction than is currently in place • The town should continue to prohibit future construction in the floodplain • The town should continue to limit the density of development in the floodplain	• The town has considered a number of options regarding zoning as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Cary	Zoning Ordinance	The Cary Zoning Ordinance regulates the type of development that can take place in certain areas of the jurisdiction. Zoning for resources/recreation is in place and can be used for open space preservation which can reduce the amount of impermeable surface area in the jurisdiction.	• The town should continue to prohibit or limit construction in the floodplain • The town should continue to limit the density of development in the floodplain	• The town has considered requiring a higher ration of permeable to impermeable surface area in new commercial construction than is currently in place, but it was determined to not be feasible
Fuquay-Varina	Zoning Ordinance	Fuquay-Varina's zoning ordinance includes various zoning districts regulating different uses of property.	• The town is willing to consider possibly establishing a provision that requires a higher ratio of permeable to impermeable surface area in new commercial construction than is currently in place • The town should continue to limit future construction in the floodplain. • The town is willing to consider possibly establishing a provision that limits the density of development in the floodplain.	• The town has considered a number of options regarding zoning as is evident in previous columns. It is at least considering implementation of all options that were considered.
Garner	UDO, Article 4: Zoning Districts	Garner's UDO includes provisions for zoning which includes overlay districts such as a conservation buffer area and Lake Benson conservation area. These can reduce the risk of flood by reducing the amount of impermeable surface area in the town and allowing the natural flow of water.	• The town should continue to prohibit or limit future construction in the floodplain • The town is willing to consider possibly limiting the density of development in the floodplain	• The town considered requiring a higher ratio of permeable to impermeable surface area in new commercial construction than is currently in place but it was determined to be not politically or economically feasible
Holly Springs	UDO	Holly Springs has a unified development ordinance that includes zoning and districts reserved for residential and commercial.	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Knightdale	UDO	Knightdale's UDO includes provisions for zoning which includes districts such as a open space preservation. This can reduce the risk of flood by reducing the amount of impermeable surface area in the town and allowing the natural flow of water.	• The town should continue to prohibit or limit future construction in the floodplain	• The town considered requiring a higher ratio of permeable to impermeable surface area in new commercial construction than is currently in place but it was determined to be not politically or economically feasible • The town considered limiting the density of development in the floodplain, but it was determined to not be politically feasible
Morrisville	Zoning Ordinance	Morrisville's zoning ordinance includes conservation buffer districts that preserve open space and can reduce the risk of flood by reducing the amount of impermeable surface area in the town and allowing the natural flow of water.	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning
Raleigh	UDO, Article 1.3: Zoning Districts	Raleigh's zoning ordinance includes conservation management areas as well as a watershed protection overlay that preserves open space and can reduce the risk of flood by reducing the amount of impermeable surface area in the town and allowing the natural flow of water.	• The city is willing to consider possibly requiring a higher ratio of permeable to impermeable surface area in new commercial construction than is currently in place • The city is willing to consider possibly prohibiting or limiting future construction in the floodplain • The city is willing to consider possibly limiting the density of development in the floodplain	• The city has considered a number of options regarding zoning as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Rolesville	UDO, Article 4: Zoning Districts	Rolesville's zoning ordinance includes various zoning districts regulating different uses of property.	• The town should continue to require a higher ratio of permeable to impermeable surface area in new commercial construction • The town should continue to limit future construction in the floodplain • The town should continue to limit the density of development in the floodplain	• The town has considered a number of options regarding zoning as is evident in previous columns. It is at least considering implementation of all options that were considered.
Wake Forest	UDO, Article 2: District Provisions	Wake Forest's zoning ordinance includes several watershed protection overlays that preserve open space and can reduce the risk of flood by reducing the amount of impermeable surface area in the town and allowing the natural flow of water.	• The town is willing to consider possibly requiring a higher ratio than is currently in place of permeable to impermeable surface area in new commercial construction. • The town should continue to limit future construction in the floodplain • The town should continue to limit the density of development in the floodplain	• The town has considered a number of options regarding zoning as is evident in previous columns. It is at least considering implementation of all options that were considered.
Wendell	UDO, Chapter 2: District Provisions	The town's zoning includes a designation for open space conservation and neighborhood conservation districts. This can help reduce people and property that are directly exposed to flooding.	• The town is willing to consider possibly requiring a higher ratio than is currently in place of permeable to impermeable surface area in new commercial construction. • The town should continue to limit future construction in the floodplain • The town should continue to limit the density of development in the floodplain	• The town has considered a number of options regarding zoning as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Zebulon	Zoning Code (Code of Ordinances Ch. 154)	Zebulon has a zoning code that includes districts dedicated to open space conservation. These can help by allowing the natural flow of water back into the system.	• The town is willing to consider possibly requiring a higher ratio than is currently in place of permeable to impermeable surface area in new commercial construction. • The town should continue to limit future construction in the floodplain • The town should continue to limit the density of development in the floodplain	• The town has considered a number of options regarding zoning as is evident in previous columns. It is at least considering implementation of all options that were considered.

E.1.4 Subdivision Regulations

Subdivision ordinances are typically enacted on a much smaller scale than any of the previously discussed types of prevention activities. Often, subdivision regulations address specific neighborhoods and the types of activities that might be carried out there. Many subdivision ordinances govern standards that must be put in to place when a new development is being designed, but subdivision ordinances also often provide incentives for the inclusion of best practices in flood management into development. Each of the jurisdictions that participated in the Hazard Mitigation Planning process considered several activities that attempt to reduce flood risk through subdivision ordinances.

As described in **Table E.4**, in some cases, it was determined that local governments were already implementing risk reducing activities and merely needed to formalize their commitment to continue to enact these measures. In general, communities were either already implementing subdivision ordinance activities or were working towards implementing these activities in the near future. However, some activities that were considered for implementation could not be incorporated into the local government's implementation structure. In cases where activities were considered, but could not be moved forward, the activity has been identified and an explanation of why it would not be feasible has been included.

TABLE E.4: SUBDIVISION ORDINANCE ACTIVITIES

Preventative Activities				
Subdivision Ordinance— A subdivision ordinance is intended to regulate the development of residential, commercial, industrial, or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development. Subdivision design that accounts for natural hazards can dramatically reduce the exposure of future development. For example, a subdivision ordinance can help reduce future flood risk by including risk reducing actions on a lot level such as tree planting requirements or encouraging the use of rain barrels. These ordinances are an appropriate activity that Wake County and its municipalities can use to reduce future flood losses since each community already has a form of subdivision ordinance in place.				
Jurisdiction	**Current Standards/ Regulations**	**Local Implementation**	**Recommendations for Future Implementation**	**Changes Considered but Discounted as Not Feasible**
Wake County	UDO, Article 8: Subdivision Design and Improvements	The Wake County Subdivision Ordinance includes requirements that new subdivisions provide adequate drainage systems and stormwater management devices, as well as erosion and sedimentation control devices. These devices recognize the importance of controlling the flow of water and reducing the impacts of flooding.	• The county is willing to consider possibly incentivizing the use of rain barrels or rain gardens • The county is willing to consider possibly requiring more trees be preserved and planted in landscape designs to reduce stormwater runoff • The county is willing to consider possibly requiring a drainage study with new development	• The county has considered a number of options regarding subdivision ordinances as is evident in previous columns. It is at least considering implementation of all options that were considered.
Apex	UDO, Article 7: Subdivision	The Apex Subdivision Ordinance includes a requirement that any time land is sub-divided for residential purposes, there must also be a dedication of a portion of that land to providing a park or recreation space or a fee in lieu of such space. This can help reduce the amount of impermeable surface area in the jurisdiction and thus reduce flood risk.	• The town should continue to implement its incentive program for the use of rain barrels and/or rain gardens • The town should continue to require more trees be preserved and planted in landscape designs to reduce stormwater runoff • The town should continue to require a drainage study with new development.	• The town has considered a number of options regarding subdivision ordinances as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Cary	LDO, Chapter 8: Standards for Subdivisions and Uses	The Cary Subdivision Ordinance includes a requirement that any time land is sub-divided for residential purposes, there must also be a dedication of a portion of that land to providing a park or recreation space or a fee in lieu of such space. This can help reduce the amount of impermeable surface area in the jurisdiction and thus reduce flood risk.	• The town is willing to consider possibly incentivizing the use of rain barrels or rain gardens • The town is willing to consider possibly requiring more trees be preserved and planted in landscape designs to reduce sotrmwater runoff • The town should continue to require a drainage study with new development	• The town has considered a number of options regarding subdivision ordinances as is evident in previous columns. It is at least considering implementation of all options that were considered.
Fuquay-Varina	Subdivision Regulations	The Fuquay-Varina Subdivision Ordinance includes a requirement that any time land is sub-divided for residential purposes, there must also be a dedication of a portion of that land to providing a park or recreation space or a fee in lieu of such space. This can help reduce the amount of impermeable surface area in the jurisdiction and thus reduce flood risk.	• The town is willing to consider possibly establishing a provision that incentivizes the use of rain barrels and/or rain gardens • The town is willing to require more trees be preserved and planted in landscape designs to reduce stormwater runoff • The town is willing to consider possibly establishing a provision that requires a drainage study with new development	• The town has considered a number of options regarding subdivision ordinances as is evident in previous columns. It is at least considering implementation of all options that were considered.
Garner	UDO, Article 8: Subdivision Design/Improveme nts	The Garner Subdivision Ordinance includes a requirement that any time land is sub-divided for residential purposes, there must also be a dedication of a portion of that land to providing a park or recreation space or a fee in lieu of such space. This can help reduce the amount of impermeable surface area in the jurisdiction and thus reduce flood risk.	• The town is willing to consider possibly incentivizing the use of rain barrels or rain gardens • The town is willing to consider requiring more trees be preserved and planted in landscape designs to reduce stormwater runoff • The town is willing to consider possibly requiring a drainage study with new development	• The town has considered a number of options regarding subdivision ordinances as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Holly Springs	UDO	The Holly Springs Unified Development Ordinance contains requirements related to subdivision development such as landscape regulations and open space preservation provisions for new development. These can help to reduce flood risk by preserving permeable surface area in the jurisdiction and controlling water flow.	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning
Knightdale	UDO	The Knightdale Unified Development Ordinance contains requirements related to subdivision development such as landscape regulations and open space preservation provisions for new development. These can help to reduce flood risk by preserving permeable surface area in the jurisdiction and controlling water flow.	• The town should continue to incentivize the use of rain barrels and rain gardens • The town should continue to require more trees be preserved and planted in landscape designs to reduce stormwater runoff • The town is willing to consider possibly requiring a drainage study with new development	• The town has considered a number of options regarding subdivision ordinances as is evident in previous columns. It is at least considering implementation of all options that were considered.
Morrisville	Subdivision Ordinance	The Morrisville Subdivision Ordinance includes a requirement that any time land is sub-divided for residential purposes, there must also be a dedication of a portion of that land to providing a park or recreation space or a fee in lieu of such space. This can help reduce the amount of impermeable surface area in the jurisdiction and thus reduce flood risk.	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Raleigh	UDO, Article 8: Subdivision and Site Plan Standards	The Raleigh Subdivision Ordinance includes a number of requirements related to stormwater management and generally works to prevent impeding the flow of natural waterways. This can help reduce the amount of impermeable surface area in the jurisdiction and thus reduce flood risk.	• The city is willing to consider possibly incentivizing the use of rain barrels or rain gardens • The city is willing to consider possibly requiring more trees be preserved and planted in landscape designs to reduce stormwater runoff • The city should continue to require a drainage study with new development	• The city has considered a number of options regarding subdivision ordinances as is evident in previous columns. It is at least considering implementation of all options that were considered.
Rolesville	UDO, Chapter 15: Subdivision Standards	The Rolesville Subdivision Ordinance includes a requirement that any time land is sub-divided for residential purposes, there must also be a dedication of a portion of that land to providing a park or recreation space or a fee in lieu of such space. This can help reduce the amount of impermeable surface area in the jurisdiction and thus reduce flood risk.	• The town is willing to consider possibly incentivizing the use of rain barrels or rain gardens • The town is willing to require more trees be preserved and planted in landscape designs to reduce stormwater runoff • The town should continue to require a drainage study with new development	• The town has considered a number of options regarding subdivision ordinances as is evident in previous columns. It is at least considering implementation of all options that were considered.
Wake Forest	UDO, Article 6: Subdivision and Infrastructure Standards	The Wake Forest Subdivision Ordinance includes a number of provisions related to stormwater management and flood prevention. For example, it is required that the 100 year floodplain be shown on all plats. This can help demonstrate areas of flood risk thus potentially reduce the number of structures in the floodplain.	• The town is willing to consider possibly incentivizing the use of rain barrels or rain gardens • The town should continue to require more trees be preserved and planted in landscape designs to reduce stormwater runoff • The town is willing to require a drainage study with new development	• The town has considered a number of options regarding subdivision ordinances as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Wendell	UDO, Chapter 16: Development Plan Requirements	The Wendell Subdivision Ordinance includes a number of provisions related to flood prevention including flood and stormwater permit requirements . These can help demonstrate areas of flood risk thus potentially reduce the number of structures in the floodplain.	• The town is willing to consider possibly incentivizing the use of rain barrels or rain gardens • The town is willing to consider possibly requiring more trees be preserved and planted in landscape designs to reduce stormwater runoff	• The town considered requiring a drainage study with new development but it was determined to be not politically feasible
Zebulon	Subdivision Regulations (Code of Ordinances Ch. 155)	The Zebulon Code of Ordinances contains requirements related to subdivision development and stormwater management. These can help to reduce flood risk by controlling water flow.	• The town is willing to consider possibly incentivizing the use of rain barrels or rain gardens • The town is willing to consider possibly requiring more trees be preserved and planted in landscape designs to reduce stormwater runoff • The town is willing to consider possibly requiring a drainage study with new development	• The town has considered a number of options regarding subdivision ordinances as is evident in previous columns. It is at least considering implementation of all options that were considered.

E.1.5 Stormwater Management

Somewhat distinct from many of the other categories of prevention activities, stormwater management encompasses activities that deal with water runoff during storm events that is managed and directed by the local government entity. Stormwater management issues have become an especially prominent discussion point in the arena of flood risk reduction for local governments because of this responsibility. Each of the jurisdictions that participated in the Hazard Mitigation Planning process considered several activities that attempt to reduce flood risk through stormwater management.

As described in **Table E.5**, in some cases, it was determined that local governments were already implementing risk reducing activities and merely needed to formalize their commitment to continue to enact these measures. In general, communities were either already implementing stormwater management activities or were working towards implementing these activities in the near future. However, some activities that were considered for implementation could not be incorporated into the local government's implementation structure. In cases where activities were considered, but could not be moved forward, the activity has been identified and an explanation of why it would not be feasible has been included.

TABLE E.5: STORMWATER MANAGEMENT ACTIVITIES

Preventative Activities				
Stormwater Management— A stormwater management plan is designed to address flooding associated with stormwater runoff. The stormwater management plan is typically focused on design and construction measures that are intended to reduce the impact of more frequently occurring minor urban flooding. For example, stormwater management regulations or plans can help reduce future flood risk by requiring restrictions on development in upland areas to reduce stormwater run-off or adopting Phase II stormwater regulations. Stormwater management plans are an appropriate activity that Wake County and its municipalities can use to reduce future flood losses since each community is working to develop or already has a form of stormwater management in place.				
Jurisdiction	**Current Standards/ Regulations**	**Local Implementation**	**Recommendations for Future Implementation**	**Changes Considered but Discounted as Not Feasible**
Wake County	UDO, Article 9: Stormwater Management	The Wake County Stormwater Management ordinance includes an incentive system that allows developers to earn credits by implementing better site designs and locating development in a manner that reduces the impact on aquatic resources. One of the main tenets of the ordinance is to reduce impervious surfaces in the jurisdiction.	• The county should continue to update and maintain its current stormwater regulations since it has the technical and financial capability to do so	• The county considered setting compensatory water storage requirements for new construction but it was determined to be not politically feasible • The county considered regulating development in upland areas in order to reduce stormwater runoff but it was determined to be no politically feasible • The county considered linking flood hazard mitigation objectives with EPA Stormwater Phase II initiatives but it was determined to be not politically feasible
Apex	EPA Phase II Stormwater Regulations are overseen by the Public Works and Utilities Department; UDO, Article 6.1: Watershed Protection Overlay Districts (furthers the goals NPDES)	Under the Apex Stormwater Management Ordinance, the Town is required to obtain a Phase II National Pollutant Discharge Elimination System (NPDES) permit for stormwater management for its municipal separate storm sewer system and to adopt, among other things, requirements and procedures to control the adverse effects of increased post development stormwater runoff and nonpoint and point source pollution associated with new development and redevelopment	• The town is willing to consider possibly setting compensatory storage requirements for new construction • The town should continue to regulate development in upland areas in order to reduce stormwater runoff • The town should continue to link flood hazard mitigation objectives with EPA Stormwater Phase II initiatives	• The town considered a number of options regarding stormwater management as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Cary	Stormwater Master Plan; LDO, Chapter 4.4.6: Watershed Protection Overlay, Chapter 7.3: Stormwater Management	The Town of Cary has developed a stormwater management plan that will look at opportunities to improve stormwater management in the water quality and water quantity areas as well as funding opportunities to assist with stormwater and flooding improvements.	• The town should continue to implement its compensatory water storage requirements for new construction • The town should continue to regulate development in upland areas in order to reduce stormwater runoff • The town should continue to link flood hazard mitigation objectives with EPA Stormwater Phase II initiatives	• The town has considered a number of options regarding stormwater management as is evident in previous columns. It is at least considering implementation of all options that were considered.
Fuquay-Varina	Stormwater Management Ordinance	The Fuquay-Varina Stormwater Management Ordinance encourages the use of better management and site design practices, such as the use of vegetated conveyances for stormwater and the preservation of greenspace. It also requires that new development maintain the pre-development hydrologic response in its post development state.	• The town should continue to update and maintain its current stormwater regulations since it has the technical and financial capability to do so	• The town considered setting compensatory water storage requirements for new construction, but it was considered not politically feasible or economically feasible. • The town considered regulating development in upland areas in order to reduce stomwater runoff and although many situations that has happened, it was not economically feasible in all cases. • The town considered linking flood hazard mitigation objectives with EPA Stormwater Phase II initiatives, but it was determined to be not politically feasible.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Garner	UDO, Article 7.2: Stormwater Management	Among other elements, the Garner Subdivision Ordinance includes requirements that all developments shall have a drainage system adequate to prevent the undue retention of surface water on the development site and no development may be constructed or maintained so that surface waters from such development are unreasonably collected or diverted onto lower properties	• The town is willing to consider possibly linking flood hazard mitigation objectives with EPA Stormwater Phase II initiatives	• The town considered setting compensatory water storage requirements for new construction but it was determined to not be politically or economically feasible • The town considered regulating development in upland areas in order to reduce stormwater runoff but it was determined to not be politically or economically feasible
Holly Springs	NPDES Phase II Post-Construction Stormwater Ordinance	The Holly Springs Stormwater Ordinance explains that the town may choose to implement one or more comprehensive watershed plans with the intent to meet the minimum NPDES Phase II requirements for post-construction discharges and other local, state or federal regulations	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning
Knightdale	UDO, Ch. 6.4: Post Construction Stormwater Management	The Knightdale Unified Development Ordinance requires that new development and redevelopment maintain pre-development hydrologic response in their post-development state as nearly as practicable for the applicable design storm in order to reduce flooding, stream bank erosion, and non-point source pollution.	• The town should continue to implement its compensatory water storage requirements for new construction • The town should continue to regulate development in upland areas in order to reduce stormwater runoff • The town should continue to link flood hazard mitigation objectives with EPA Stormwater Phase II initiatives	• The town has considered a number of options regarding stormwater management as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Morrisville	Stormwater Management Ordinance	The Morrisville Stormwater Ordinance requires that Stormwater systems shall be designed to control and treat the runoff volume generated from all surfaces by one-inch of rainfall and stormwater systems shall be designed to control and treat the runoff volume generated from all surfaces by an additional one half inch of rainfall.	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning
Raleigh	UDO, Article 9.2: Stormwater Management	The City of Raleigh's Stormwater Ordinance contains a number of provisions aimed at controlling stormwater including that no development, expansion of exising development or the placement of more than 12,000 square feet of any impervious surface may occur on a site without a stormwater control permit from the Office of Development Services.	• The city should continue to set compensatory water storage requirements for new construction • The city should continue to regulate development in upland areas in order to reduce stormwater runoff • The city is willing to consider possibly linking flood hazard mitigation objectives with EPA Stormwater Phase II initiatives	• The city has considered a number of options regarding stormwater management as is evident in previous columns. It is at least considering implementation of all options that were considered.
Rolesville	UDO, Article 7.5: Stormwater Management Standards	The Rolesville Stormwater Ordinance requires that all Development and Redevelopment shall be located outside the Riparian Buffer Zone and the Flood Protection Zone in accordance with a number ofprovisions.	• The town should continue to set compensatory storage requirements for new construction • The town should continue to regualate development in upland areas in order to reduce stormwater runoff • The town should continue to link flood hazard mitigation objectives with EPA Stomwater Phase II initiatives	• The town has considered a number of options regarding stormwater management as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Wake Forest	UDO, Article 12.5: Stormwater Management	The Wake Forest Stormwater Ordinance states that new development shall not exceed 70% impervious surface on a project-by project basis and that stormwater control measures shall be installed that control and treat the difference in stormwater runoff volume leaving the project site between the pre- and post-development conditions.	• The town should continue to set compensatory storage requirements for new construction • The town should continue to regualate development in upland areas in order to reduce stormwater runoff • The town should continue to link flood hazard mitigation objectives with EPA Stomwater Phase II initiatives	• The town has considered a number of options regarding stormwater management as is evident in previous columns. It is at least considering implementation of all options that were considered.
Wendell	UDO, Chapter 6.5: Post-Construction Stormwater Ordinance	The Wendell Stormwater Ordinance explains that a stormwater permit is required for all development and redevelopment unless exempt pursuant to this ordinance. This permit shall govern the design, installation, and construction of stormwater management and control practices on the site.	• The town is willing to consider possibly setting compensatory water storage requirements for new construction • The town is willing to consider regulating development in upland areas in order to reduce stormwater runoff • The town is willing to consider linking flood hazard mitigation objectives with EPA Stormwater Phase II initiatives	• The town has considered a number of options regarding stormwater management as is evident in previous columns. It is at least considering implementation of all options that were considered.
Zebulon	Stormwater Ordinance (Code of Ordinances Ch. 151)	The Zebulon Stormwater Ordinance explains that a stormwater permit is required for all development and redevelopment unless exempt pursuant to this ordinance. This permit shall govern the design, installation, and construction of stormwater management and control practices on the site.	• The town is willing to consider possibly setting compensatory water storage requirements for new construction • The town is willing to consider regulating development in upland areas in order to reduce stormwater runoff • The town is willing to consider linking flood hazard mitigation objectives with EPA Stormwater Phase II initiatives	• The town has considered a number of options regarding stormwater management as is evident in previous columns. It is at least considering implementation of all options that were considered.

E.1.6 Building Codes

Building Codes are can help in the reduction of risk to flooding events in a number of ways. For instance, stronger building codes can help to ensure that structures are built to a standard which will allow them to resist the hydrostatic and hydrodynamic forces of flood waters. Building codes are often implemented at the local level, but in many cases, states set the actual provisions of the building code through minimum standards that communities must adopt. Each of the jurisdictions that participated in the Hazard Mitigation Planning process considered several activities that attempt to reduce flood risk through better management of identified floodplain areas.

As described in **Table E.6**, in some cases, it was determined that local governments were already implementing risk reducing activities and merely needed to formalize their commitment to continue to enact these measures. In general, communities were either already implementing building code activities or were working towards implementing these activities in the near future. However, some activities that were considered for implementation could not be incorporated into the local government's implementation structure. In cases where activities were considered, but could not be moved forward, the activity has been identified and an explanation of why it would not be feasible has been included.

TABLE E.6: BUILDING CODE ACTIVITIES

Preventative Activities				
Building Code—Building codes regulate construction standards. In many communities, permits and inspections are required for new construction. Decisions regarding the adoption of building codes (that account for hazard risk), the type of permitting process required both before and after a disaster, and the enforcement of inspection protocols all affect the level of hazard risk faced by a community. An example of how building codes can reduce flood risk is by implementing a code that requires that new buildings constructed in the floodplain are built with materials that are resistant to the anticipated velocity of floodwaters.				
Jurisdiction	**Current Standards/ Regulations**	**Local Implementation**	**Recommendations for Future Implementation**	**Changes Considered but Discounted as Not Feasible**
Wake County	Adopted 2012 North Carolina State Building Code	Appendix G of the NC State Building Code outlines regulations for flood resistant construction. Among other regulations, the code states that all permit applications for construction or substantial improvement to structures in the floodplain must by designed and constructed with methods, practices, and materials that minimize flood damage.	• Continue adopting future updates to the North Carolina State Building Code and enforcing it throughout the jurisdiction. • The county should continue to enforce higher building codes such as the International Building Code or International Residential Code • The county should continue to implement ASCE 24-05 which specifies minimum requirement and expected performance for the design and construction of buildings and structures in flood hazard areas to make them more resistant to flood loads and flood damage	• The county considered a number of options regarding building codes as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Apex	Adopted 2012 North Carolina State Building Code	Appendix G of the NC State Building Code outlines regulations for flood resistant construction. Among other regulations, the code states that all permit applications for construction or substantial improvement to structures in the floodplain must by designed and constructed with methods, practices, and materials that minimize flood damage.	• Continue adopting future updates to the North Carolina State Building Code and enforcing it throughout the jurisdiction. • The town is willing to consider possibly adopting ASCE 24-05 which specifies minimum requirement and expected performance for the design and construction of buildings and structures in flood hazard areas to make them more resistant to flood loads and flood damage.	• The town considered adopting higher building code standards such as the International Building Code or International Residential Code, but it was determined to be not politically feasible.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Cary	Adopted 2012 North Carolina State Building Code	Appendix G of the NC State Building Code outlines regulations for flood resistant construction. Among other regulations, the code states that all permit applications for construction or substantial improvement to structures in the floodplain must by designed and constructed with methods, practices, and materials that minimize flood damage.	• Continue adopting future updates to the North Carolina State Building Code and enforcing it throughout the jurisdiction • The town is willing to consider possibly adopting higher building code standards such as the International Building Code or International Residential Code • The town is willing to consider possibly adopting ASCE 24-05 which specifies minimum requirement and expected performance for the design and construction of buildings and structures in flood hazard areas to make them more resistant to flood loads and flood damage.	• The town considered a number of options regarding building codes as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Fuquay-Varina	Adopted 2012 North Carolina State Building Code	Appendix G of the NC State Building Code outlines regulations for flood resistant construction. Among other regulations, the code states that all permit applications for construction or substantial improvement to structures in the floodplain must by designed and constructed with methods, practices, and materials that minimize flood damage.	• Continue adopting future updates to the North Carolina State Building Code and enforcing it throughout the jurisdiction. • The town is willing to consider possibly adopting higher building code standards such as the International Building Code or International Residential Code • The town is willing to adopt ASCE 24-05 which specifies minimum requirement and expected performance for the design and construction of buildings and structures in flood hazard areas to make them more resistant to flood loads and flood damage.	•
Garner	Adopted 2012 North Carolina State Building Code	Appendix G of the NC State Building Code outlines regulations for flood resistant construction. Among other regulations, the code states that all permit applications for construction or substantial improvement to structures in the floodplain must by designed and constructed with methods, practices, and materials that minimize flood damage.	• Continue adopting future updates to the North Carolina State Building Code and enforcing it throughout the jurisdiction. • The town should continue to enforce higher building codes such as the International Building Code or International Residential Code	• The town considered implementing ASCE 24-05 which specifies minimum requirements and expected performance for the design and construction of buildings and structures in flood hazard areas to make them more resistant to flood loads and flood damage but it was determined to not be administratively feasible

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Holly Springs	Adopted 2012 North Carolina State Building Code	Appendix G of the NC State Building Code outlines regulations for flood resistant construction. Among other regulations, the code states that all permit applications for construction or substantial improvement to structures in the floodplain must by designed and constructed with methods, practices, and materials that minimize flood damage.	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning
Knightdale	Adopted 2012 North Carolina State Building Code	Appendix G of the NC State Building Code outlines regulations for flood resistant construction. Among other regulations, the code states that all permit applications for construction or substantial improvement to structures in the floodplain must by designed and constructed with methods, practices, and materials that minimize flood damage.	• Continue adopting future updates to the North Carolina State Building Code and enforcing it throughout the jurisdiction. • The town should continue to enforce higher building codes such as the International Building Code or International Residential Code	• The town considered implementing ASCE 24-05 which specifies minimum requirements and expected performance for the design and construction of buildings and structures in flood hazard areas to make them more resistant to flood loads and flood damage but it was determined to not be administratively feasible
Morrisville	Adopted 2012 North Carolina State Building Code	Appendix G of the NC State Building Code outlines regulations for flood resistant construction. Among other regulations, the code states that all permit applications for construction or substantial improvement to structures in the floodplain must by designed and constructed with methods, practices, and materials that minimize flood damage.	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning	• The town determined that it will not be pursuing points for CRS credit from Activity 510: Floodplain Management Planning

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Raleigh	Adopted 2012 North Carolina State Building Code	Appendix G of the NC State Building Code outlines regulations for flood resistant construction. Among other regulations, the code states that all permit applications for construction or substantial improvement to structures in the floodplain must by designed and constructed with methods, practices, and materials that minimize flood damage.	• Continue adopting future updates to the North Carolina State Building Code and enforcing it throughout the jurisdiction. • The city should continue to enforce higher building codes such as the International Building Code or International Residential Code • The city is willing to consider possibly implementing ASCE 24-05 which specifies minimum requirement and expected performance for the design and construction of buildings and structures in flood hazard areas to make them more resistant to flood loads and flood damage	• The city considered a number of options regarding building codes as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Rolesville	Adopted 2012 North Carolina State Building Code	Appendix G of the NC State Building Code outlines regulations for flood resistant construction. Among other regulations, the code states that all permit applications for construction or substantial improvement to structures in the floodplain must by designed and constructed with methods, practices, and materials that minimize flood damage.	• Continue adopting future updates to the North Carolina State Building Code and enforcing it throughout the jurisdiction. • The town should continue to implement building codes standards such as the International Building Code and/or International Residential Code • The town should continue to implement ASCE 24-05 which specifies minimum requirement and expected performance for the design and construction of buildings and structures in flood hazard areas to make them more resistant to flood loads and flood damage.	• The town has considered a number of options regarding building codes as is evident in previous columns. It is at least considering implementation of all options that were considered.

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Wake Forest	Adopted 2012 North Carolina State Building Code	Appendix G of the NC State Building Code outlines regulations for flood resistant construction. Among other regulations, the code states that all permit applications for construction or substantial improvement to structures in the floodplain must by designed and constructed with methods, practices, and materials that minimize flood damage.	• Continue adopting future updates to the North Carolina State Building Code and enforcing it throughout the jurisdiction. • The town should continue to implement building codes standards such as the International Building Code and/or International Residential Code • The town should continue to implement ASCE 24-05 which specifies minimum requirement and expected performance for the design and construction of buildings and structures in flood hazard areas to make them more resistant to flood loads and flood damage.	• The town has considered a number of options regarding building codes as is evident in previous columns. It is at least considering implementation of all options that were considered.
Wendell	Adopted 2012 North Carolina State Building Code	Appendix G of the NC State Building Code outlines regulations for flood resistant construction. Among other regulations, the code states that all permit applications for construction or substantial improvement to structures in the floodplain must by designed and constructed with methods, practices, and materials that minimize flood damage.	• Continue adopting future updates to the North Carolina State Building Code and enforcing it throughout the jurisdiction. • The town is willing to consider possibly adopting ASCE 24-05 which specifies minimum requirement and expected performance for the design and construction of buildings and structures in flood hazard areas to make them more resistant to flood loads and flood damage.	• The town considered adopting higher building code standards such as the International Building Code and/or International Residential Code but it was determined to be not politically feasible

Jurisdiction	Current Standards/ Regulations	Local Implementation	Recommendations for Future Implementation	Changes Considered but Discounted as Not Feasible
Zebulon	Adopted 2012 North Carolina State Building Code	Appendix G of the NC State Building Code outlines regulations for flood resistant construction. Among other regulations, the code states that all permit applications for construction or substantial improvement to structures in the floodplain must by designed and constructed with methods, practices, and materials that minimize flood damage.	• Continue adopting future updates to the North Carolina State Building Code and enforcing it throughout the jurisdiction. • The town is willing to consider possibly adopting higher building code standards such as the International Building Code or International Residential Code • The town is willing to consider possibly adopting ASCE 24-05 which specifies minimum requirement and expected performance for the design and construction of buildings and structures in flood hazard areas to make them more resistant to flood loads and flood damage.	• The town has considered a number of options regarding building codes as is evident in previous columns. It is at least considering implementation of all options that were considered.

Appendix F
Public Involvement

This appendix includes:

1. Public Involvement Summary
2. Public Outreach Documentation
3. Public Survey Summary Results

PUBLIC INVOLVEMENT SUMMARY

Stakeholders outside of participating local government staff and officials were alerted to the planning process and invited to participate in several ways. There was publicity of the project kickoff meeting, a Public Survey, extensive recruitment for the project Coordinating Committee, and an online Project Wiki.

Outreach Prior to Project Kickoff Meeting

The project kickoff meeting (held November 21, 2013) was widely publicized on local government online calendars and newsletters as well as in the in Triangle J Council of Governments (TJCOG) weekly newsletter (distribution of 1,718 Triangle-wide). A press release was sent to the two major newspapers in Wake County, the Raleigh News & Observer and the Raleigh Public Record. A Public Notice was published about the process and the kickoff meeting in the News & Observer. Staff of participating local governments also disseminated the Public Notice through local channels (e-blasts, Facebook, Twitter, public information officers, official government websites, online event calendars, etc.) as well as to numerous local government departments not already involved in the planning effort.

Local staff were also asked to personally forward the meeting announcement to local advisory boards and committees as well as at least 3 community leaders NOT affiliated with their local government, such as nonprofit organizations, social services agencies/affordable housing advocates, grade schools/PTAs/high schools, academia (NCSU, Wake Tech), Cooperative Extension, business/industry, State and Federal agencies, cultural institutions, Capital Area MPO Technical Advisory and Technical Coordinating Committees, HOAs and property managers, neighborhood groups, CERTs, religious institutions, special populations (ESL, elder care), etc.

The following stakeholders and organizations were invited to the kickoff meeting by Triangle J Council of Governments by direct personal email:

- NC State and Wake County Cooperative Extension
- Red Cross
- Capital Area Metropolitan Planning Organization (CAMPO) staff
- US Army Corps of Engineers (operator of Falls Lake)
- Director of Public Health for Wake County
- Director of Senior & Adult Services in Wake Human Services
- Transportation Demand Management (TDM) Coordinators with the City of Raleigh, Triangle Transit, Wake Technical Community College, RTP, and NCSU.

These entities were also provided a links to online the Public Survey, Word files of the Survey in English and Spanish, and links to the online Project Wiki.

Additional Outreach

After the kickoff meeting, Triangle J Council of Governments continued to identify and contact additional stakeholders to invite them participate. The following stakeholders were also contacted to help disseminate and to take the Public Survey; to submit a point of contact for the Coordinating

Committee; and invited to visit the Project Wiki with draft Plan components, information about the process, and contact information for each participating local government.

- Elementary and middle school facilities managers
- Raleigh-Wake Chamber of Commerce
- Wake County's five active Community Emergency Response Teams[1]
- The Downtown Raleigh Alliance (a nonprofit network of property owners, government officials, and business owners)
- Raleigh-Durham Authority (the entity responsible for management of the Triangle region's international airport)
- Duke Energy
- Alliance for Disability Advocates
- Large employers
- NC State University, Shaw University, Campbell University, Meredith College, Peace College, and Wake Technical Community College

The Public Survey was posted to the online project wiki as well as to participating local government websites, e-blasts, and social media. Triangle J Council of Governments also sent the Public Survey link and Word documents in English and in Spanish in a personal email to the following people and organizations requesting dissemination to their networks:

- Raleigh Parks and Recreation Department
- El Pueblo
- Club Choice
- The Red Cross of Wake County

The following organizations were especially involved in disseminating the Public Survey:

- Millbrook Human Services Center distributed hard copies in both English and Spanish directly to their clients
- Alianza Latina Pro-Educación en Salud (ALPES) of Wake County put a survey announcement in their newsletter (>100 recipients) and offered to distribute the Word version in English and Spanish
- Rogelio Valencia, Latino Ombudsman with the N.C. Department of Health and Human Services and the State Emergency Response Team Privacy/Repatriation Coordinator (Division of Social Services) posted survey links, Word files, and announcements to his networks and listserv
- The Wake County Alliance for Disability Advocates included survey announcement in their newsletters and posted survey links to website and Facebook. They also provided a service to input survey responses for anyone unable to use the survey form.

Also, WRAL television news anchor Bill Leslie reported on the Hazard Mitigation Plan and the Public Survey on February 17, 2014. He also informed viewers that the survey was available on the station's website; it was posted online with a brief summary of the process.

---

[1] Contact information for Wake County CERT leads obtained from Ms. Patty Moore at the NC Department of Public Safety. TJCOG sent the invitation to participate on the Coordinating Committee and survey information to the five CERT leads and asked them to forward the email to the rest of their CERT members. Eight CERT members volunteered to participate on the Coordinating Committee.

NEWS BRIEFS

Wake seeks input for natural disaster readiness plan

Posted 9:25 p.m. yesterday
Updated 9:28 p.m. yesterday

RALEIGH, N.C. — Last week's crippling snowstorm has Wake County officials thinking about natural disasters and the best ways to deal with the risks associated with them.

The county is seeking the public's help to update its Hazard Mitigation Plan to help make the county less vulnerable to natural events, such as hurricanes, tornadoes, wildfires and snowstorms.

The online survey is available for Wake County residents until March 30.

The plan covers the county and its 12 municipalities – Apex, Cary, Garner, Holly Springs, Knightdale, Fuquay-Varina, Morrisville, Raleigh, Rolesville, Wake Forest, Wendell, and Zebulon.

Looking for comments?

CREDITS

Web Editor Kelly Gardner

Hazard Mitigation Planning

The county, along with local jurisdictions and other partners, are working to prepare a multi-jurisdictional Hazard Mitigation Plan. This Plan will identify and assess our community's natural hazard risks and determine how to best minimize or manage those risks.

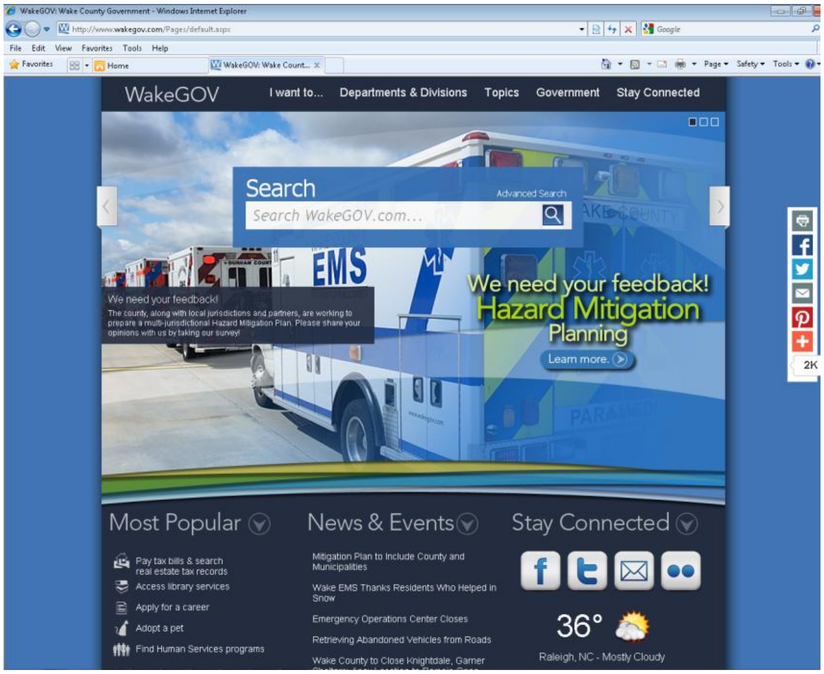
Your participation is important to us! Please take our survey, which is an opportunity for you to share your opinions and participate in the mitigation planning process. The information you provide will help us better understand your hazard concerns and can lead to mitigation activities that should help lessen the impacts of future hazard events.

Please help us by completing this survey by **March 30, 2014**.

Take our survey online now!

If you have any questions regarding this survey or would like to learn about more ways you can participate in the development of the Wake County Multi-Jurisdictional Hazard Mitigation Plan, please contact Atkins, planning consultant for the project. You may reach Nathan Slaughter (Atkins) at 919-431-5251 or by email at nathan.slaughter@atkinsglobal.com. Learn more about this project.

Published by Chris H. Smith on Friday, February 14, 2014.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We need your feedback!
The county, along with local jurisdictions and partners, are working to prepare a multi-jurisdictional Hazard Mitigation Plan. Please share your opinions with us by taking our survey!
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2K
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Pay tax bills & search real estate tax records
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Apply for a career
Adopt a pet
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Mitigation Plan to Include County and Municipalities
Wake EMS Thanks Residents Who Helped in Snow
Emergency Operations Center Closes
Retrieving Abandoned Vehicles from Roads
Wake County to Close Knightdale, Garner
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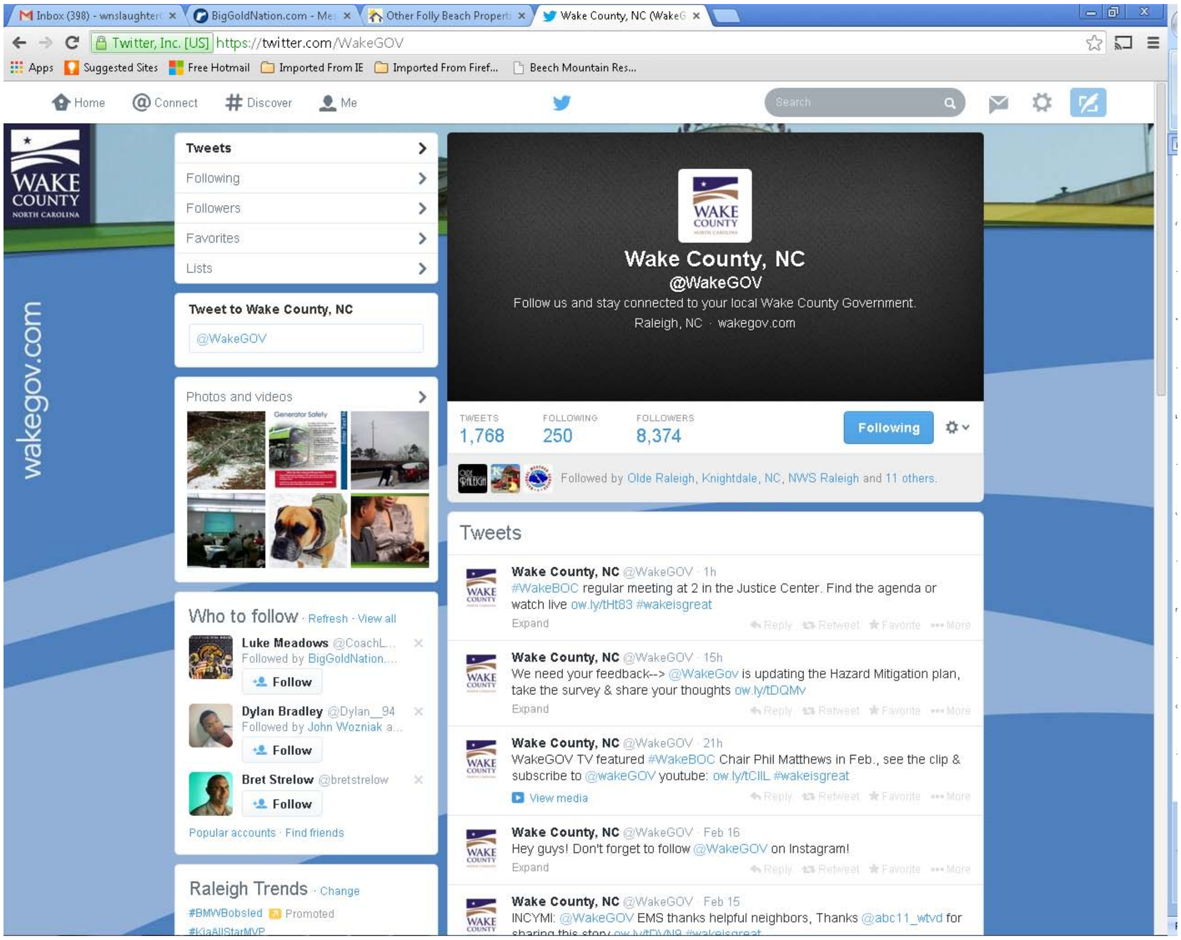
Raleigh, NC - Mostly Cloudy



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TWEETS 1,768
FOLLOWING 250
FOLLOWERS 8,374
Following
Followed by Olde Raleigh, Knightdale, NC, NWS Raleigh and 11 others.
Tweets
Wake County, NC @WakeGOV · 1h
#WakeBOC regular meeting at 2 in the Justice Center. Find the agenda or watch live ow.ly/tHt83 #wakeisgreat
Wake County, NC @WakeGOV · 15h
We need your feedback--> @WakeGov is updating the Hazard Mitigation plan, take the survey & share your thoughts ow.ly/tDQMv
Wake County, NC @WakeGOV · 21h
WakeGOV TV featured #WakeBOC Chair Phil Matthews in Feb., see the clip & subscribe to @wakeGOV youtube: ow.ly/tCIIL #wakeisgreat
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WAKE COUNTY NORTH CAROLINA

Hazard Mitigation Planning - Windows Internet Explorer

http://www.wakegov.com/em/hmp/Pages/default.aspx

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EM: Home | Preparedness | Emergency Info | Hazard Mitigation Plan | Volunteer Opportunities | LEPC

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- Hazard Mitigation Plan
- We need your feedback on the Hazard Mitigation Plan!
- Pet Safety
- Protecting Your Home
- Recovery
- Register for Emergency Notifications
- Shelter and Evacuation Information
- Special Needs Individuals
- Staying Informed

Hazard Mitigation Planning

The county, along with local jurisdictions and other partners, are working to prepare a multi-jurisdictional Hazard Mitigation Plan. This Plan will identify and assess our community's natural hazard risks and determine how to best minimize or manage those risks.

Your participation is important to us! Please take our survey, which is an opportunity for you to share your opinions and participate in the mitigation planning process. The information you provide will help us better understand your hazard concerns and can lead to mitigation activities that should help lessen the impacts of future hazard events.

Please help us by completing this survey by **March 30, 2014**.

Take our survey online now!

If you have any questions regarding this survey or would like to learn about more ways you can participate in the development of the Wake County Multi-Jurisdictional Hazard Mitigation Plan, please contact Atkins, planning consultant for the project. You may reach Nathan Slaughter (Atkins) at 919-431-5251 or by email at nathan.slaughter@atkinsglobal.com. Learn more about this project.

Published by Chris H. Smith on Friday, February 14, 2014.

1

9:07 AM

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Planning

The Planning Department provides assistance and direction to property owners and residents and also serves as technical staff support for the Board of Commissioners, Planning Board, Tree Board, Technical Review Committee and Board of Adjustment. Through the preparation of land use plans and the administration of existing land use ordinances, it is our goal to ensure responsible and thoughtful land development so as to foster a thriving and healthy community.

The Planning Department handles tasks such as flood plain development permitting, minor and major subdivision plat review, new address assignments, code enforcement, site plan and landscape approval, zoning inspections, and issuance of building permits.

Long range planning projects include maintaining the comprehensive plan and multi-modal transportation plan, performing computerized mapping using Geographical Information Systems (GIS), conducting population and housing studies, and responding to grant and funding opportunities.

We need your participation in our Hazard Mitigation Survey. Please click here.

Find out more about the Hazard Mitigation Plan here.

Morrisville
NORTH CAROLINA

You are here: Home > News Flash

Planning

Posted on: November 5, 2013

Public Meeting Notice: Wake County Hazard Mitigation Plan

Notice is hereby given that Wake County and its municipalities are joining together to develop a multi-jurisdictional hazard mitigation plan, and are seeking input from the public. Previously, each jurisdiction had developed its own, individual Hazard Mitigation Plans which are now being consolidated into one plan.

The general purposes of the plan are to protect life and property by reducing the potential for future damages and economic losses that result from natural hazards, allow the participating communities to qualify for pre- and post-disaster grant funding, facilitate recovery and redevelopment following disaster events, demonstrate a firm local commitment to hazard mitigation principles, and comply with state and federal requirements for disaster recovery and mitigation funding.

There will be a project kickoff meeting that is open to the public on November 21, 2013 from 10:00 am until noon. The meeting will be held at the Wake County Office Building, 337 S. Salisbury St., Raleigh, NC 27601 in Room G31.

Next ⇒
Church Street Sidewalks Open House

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Church Street Sidewalks Open House
Posted on: October 28, 2013

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The Planning Department handles tasks such as flood plain development permitting, minor and major subdivision plat review, new address assignments, code enforcement, site plan and landscape approval, zoning inspections, and issuance of building permits.

Long range planning projects include maintaining the comprehensive plan and multi-modal transportation plan, performing computerized mapping using Geographical Information Systems (GIS), conducting population and housing studies, and responding to grant and funding opportunities.

We need your participation in our transportation survey. To find out more about it, click here. To go directly to the MetroQuest Survey click here.

NOTICE OF PUBLIC MEETING

WAKE COUNTY HAZARD MITIGATION PLAN

Notice is hereby given that Wake County and its municipalities are joining together to develop a multi-jurisdictional hazard mitigation plan, and are seeking input from the public. Previously, each jurisdiction had developed its own, individual Hazard Mitigation Plans which are now being consolidated into one plan.

The general purposes of the plan are to protect life and property by reducing the potential for future damages and economic losses that result from natural hazards, allow the participating communities to qualify for pre- and post-disaster grant funding, facilitate recovery and redevelopment following disaster events, demonstrate a firm local commitment to hazard mitigation principles, and comply with state and federal requirements for disaster recovery and mitigation funding.

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Monday, December 16
7:00pm Planning Board Meeting
Tuesday, December 17
2:00pm Senior Activity - Wii Bov
7:00pm Town Board Meeting
Wednesday, December 18
1:00pm Senior Game Day
Thursday, December 19
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Find a listing of community events in Fuquay-Varina! The holidays are busy!
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November 27 at 12:15pm via mobile · Like · 1

Brad Honeycutt If it were after December 21st, it would mean snow in the next 10 days. Not sure what it means for fall, but snow would be fun!
November 27 at 8:51pm via mobile · Like · 1

Write a comment...

Knightdale, NC Town Hall shared a link.
November 26

This mobile site from NCDOT can help you avoid highway troubles during this week's travel. Be safe!

NCDOT Mobile
www.ncdot.gov
NCDOT Mobile Services site

Like · Comment · Share
2 people like this.
Write a comment...

Knightdale, NC Town Hall shared a link.
November 25

Traveling this week? NCDOT has a mobile site with traffic and emergency updates.

NCDOT Mobile
www.ncdot.gov
NCDOT Mobile Services site

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Cindy Clark Southard likes this.
Write a comment...

Knightdale, NC Town Hall shared a link.
November 22

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Wanda Johnson Orsett I think that is a wonderful idea......
November 27 at 11:24am · Like · 1

Aimee Michard Self Hey Wanda!!
December 2 at 10:23am · Like

Write a comment...

Knightdale, NC Town Hall shared a link.
November 26

We need your input. Wake County has put together a short survey to gauge preparedness for natural disasters. Please take a moment and weigh in. Thanks!

Public Survey for Hazard Mitigation Planning (Wake County)
www.surveygizmo.com
Public Survey for Hazard Mitigation Planning (Wake County). Created using SurveyGizmo, online survey software.

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Knightdale, NC Town Hall
November 25

Knightdale Town Hall is open through Wednesday this week. We hope you and your family have an excellent Thanksgiving celebration!

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Knightdale, NC Town Hall shared a link.
November 22

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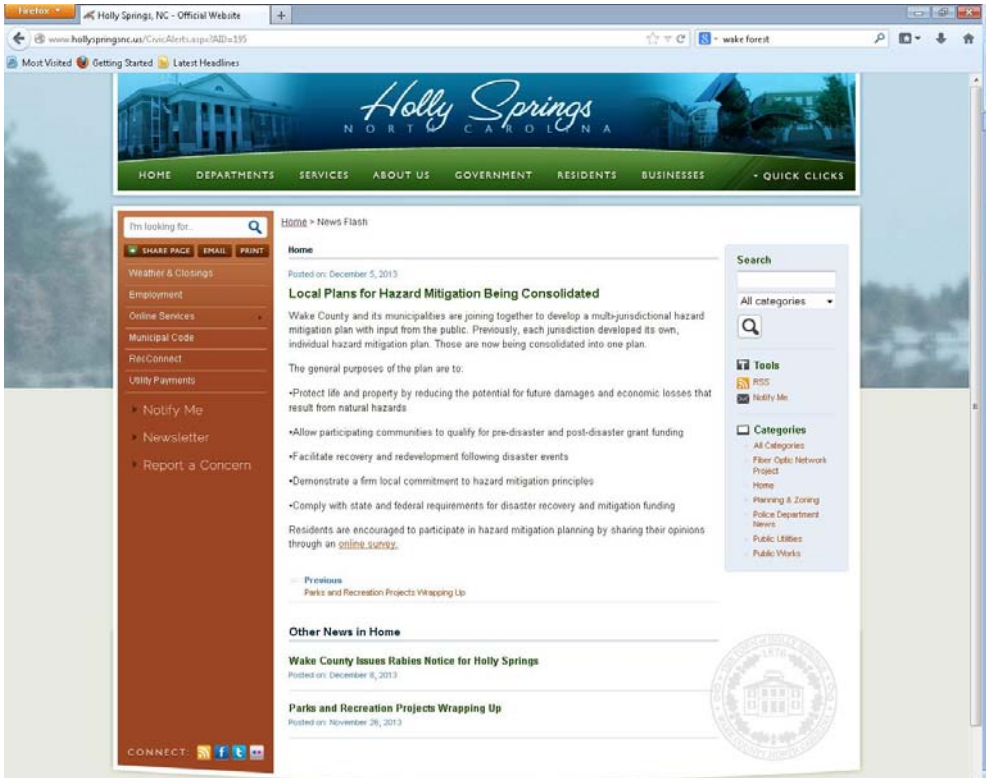
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Home
Posted on: December 5, 2013
Local Plans for Hazard Mitigation Being Consolidated
Wake County and its municipalities are joining together to develop a multi-jurisdictional hazard mitigation plan with input from the public. Previously, each jurisdiction developed its own, individual hazard mitigation plan. Those are now being consolidated into one plan.
The general purposes of the plan are to:
•Protect life and property by reducing the potential for future damages and economic losses that result from natural hazards
•Allow participating communities to qualify for pre-disaster and post-disaster grant funding
•Facilitate recovery and redevelopment following disaster events
•Demonstrate a firm local commitment to hazard mitigation principles
•Comply with state and federal requirements for disaster recovery and mitigation funding
Residents are encouraged to participate in hazard mitigation planning by sharing their opinions through an online survey.
Previous
Parks and Recreation Projects Wrapping Up
Other News in Home
Wake County Issues Rabies Notice for Holly Springs
Posted on: December 6, 2013
Parks and Recreation Projects Wrapping Up
Posted on: November 26, 2013
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All categories
Tools
RSS
Notify Me
Categories
All Categories
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Police Department News
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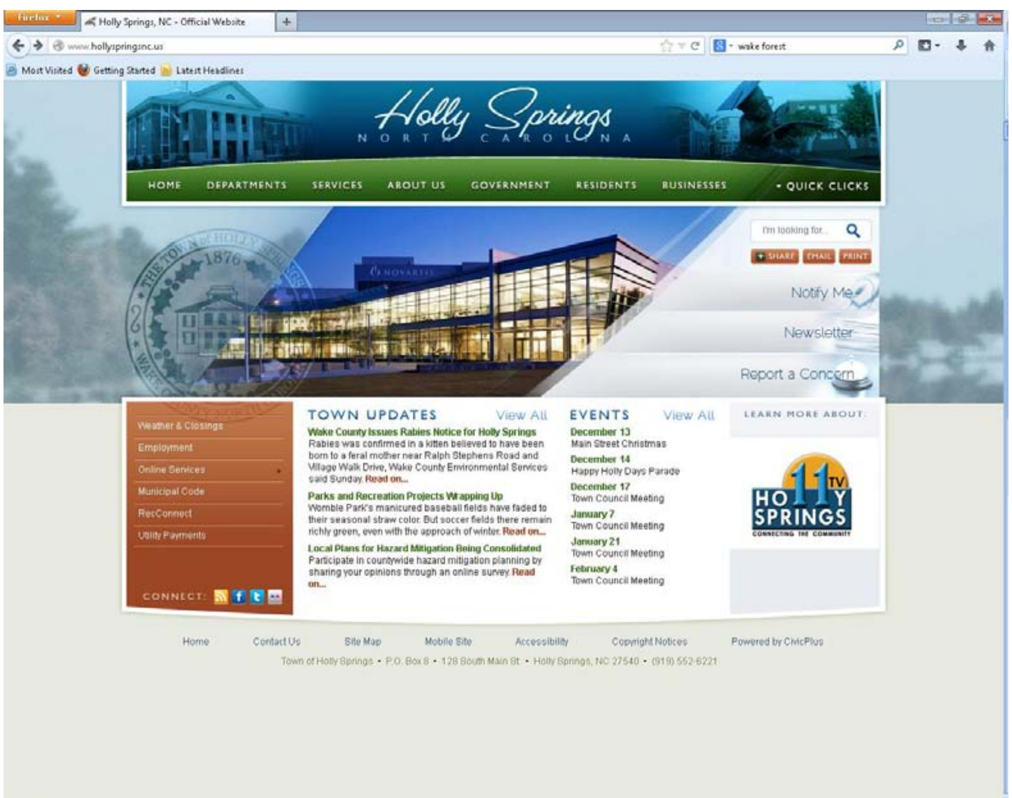
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Wake County Issues Rabies Notice for Holly Springs
Rabies was confirmed in a kitten believed to have been born to a feral mother near Ralph Stephens Road and Village Walk Drive, Wake County Environmental Services said Sunday. Read on...
Parks and Recreation Projects Wrapping Up
Womble Park's manicured baseball fields have faded to their seasonal straw color. But soccer fields there remain richly green, even with the approach of winter. Read on...
Local Plans for Hazard Mitigation Being Consolidated
Participate in countywide hazard mitigation planning by sharing your opinions through an online survey. Read on...
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Main Street Christmas
December 14
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December 17
Town Council Meeting
January 7
Town Council Meeting
January 21
Town Council Meeting
February 4
Town Council Meeting
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Holiday Solid Waste Schedule Changes - 1/1/2014
The Town of Garner will not have solid waste collection on Wednes...read more

ATTENTION TIME WARNER CABLE CUSTOMERS - 12/8/2013
Time Warner Cable has begun broadcasting the Town's public, educa...read more

Participate in Public Survey for Hazard Mitigation Planning - 12/6/2013
Wake County is working together to become less vulnerable to natu...read more

The December Newsletter is Here! - 12/5/2013
Parade and tree-lighting information and more in this month's Gar...read more

GARNER NAMED ONE OF TOP FIVE CITIES OR TOWNS IN NC - 11/21/2013
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TOWN OF APEX

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UPCOMING DATES & EVENTS

12/11/13
Parks, Recreation & Cultural Resources Advisory Commission

12/17/13
Town Council Meeting

12/24/13
Holiday - Town Offices Closed

12/25/13
Holiday - Town Offices Closed

12/26/13
Holiday - Town Offices Closed

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Town News

Apex Adds Another Top Ranking
Another accolade has been bestowed on the Town of Apex: #1 Town in North Carolina. Movoto, …… more >

Solid Waste Collection Delayed for Holidays
During the weeks of Dec 22-28 and Dec 29 - Jan 5, solid waste and recycling collection will …… more >

More with Maps
For decades, Apex staff has been using geographic information services (GIS) technology for …… more >

Input Welcome for Hazard Mitigation Plan
Wake County and its municipalities are joining together to develop a multi-jurisdictional ha…… more >

Leaf Collection Tips for Peak Season
Apex residents enjoy the benefit of weekly leaf (and other yard waste) collection. All

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Solid Waste
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Road Work Expected on Church Street and McCrimmon Parkway - Click Here for Details!
Take the Wake County Hazard Mitigation Plan Survey!
CALENDAR OF EVENTS
{view all}
Thu, Dec. 12 Planning and Zoning Board Meeting
Mon, Dec. 16 Community Appearance Committee
Tue, Dec. 24 - Thu, Dec. 26 Holiday, Town Offices Closed
Wed, Jan. 1 Holiday, Town Offices Closed
Tue, Jan. 7 Public Safety Advisory Committee
Wed, Jan. 15 Veterans Memorial Subcommittee of the Parks and Rec Advisory Committee
Thu, Jan. 16 RAIN Advisory Committee
Wed, Jan. 22 Community Appearance Committee
Wed, Feb. 5 Environmental & Recycling Advisory Committee
Wed, Feb. 12 Veterans Memorial Subcommittee of the Parks and Rec Advisory Committee
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Groundbreaking for "The L" is in about an hour. If you are joining us, we will be outdoors!
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Wake County, NC @WakeGOV · 29 Nov
Did you know we have a Wake County LinkedIn account? Its a great way to keep up with career opportunities and business news....
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Wake County, NC @WakeGOV · 27 Nov
@BrunoStAujus The CCW permit office will not be open Friday. They will be open again on Monday.
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TBJ Raleigh/Durham @TriangleBIZJrnl · 26 Nov
Did you know: #Raleigh's economy is larger than that of Sri Lanka? bizjournals.com/triangle/news/... @raleighchamber @RaleighWake
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Knightdale, NC @KdaleNC · 26 Nov
Got a sec? Please fill out this short survey from @WakeGOV about natural disasters bit.ly/1c6Cdok
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Wake County, NC @WakeGOV · 26 Nov
Don't forget that @wakegov is closed Thursday and many locations are closed Friday (parks are open!) ow.ly/rc0Ps #thanksgiving
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Wake County, NC @WakeGOV · 25 Nov
@malisaprice @anthonyprice Sorry to hear you had trouble this weekend. @raleighgov has temporary street closings ow.ly/r9zhN
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Wake County, NC @WakeGOV · 22 Nov
Need a happy thought for your Friday? Next week is a short! #thanksgiving weekend hours -------------> ow.ly/r667c #tgif
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Wake County Econ Dev @RaleighWake · 21 Nov

Firefox | Outlook - nslaughter@hotmail.com | Input Welcome for Hazard Mitigation...

www.apexnc.org/news/news/input-welcome-for-hazard-mitigation-plan

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Input Welcome for Hazard Mitigation Plan

Posted November 8, 2013

Wake County and its municipalities are joining together to develop a multi-jurisdictional hazard mitigation plan, and are seeking input from the public. Previously, each jurisdiction had developed its own, individual Hazard Mitigation Plans which are now being consolidated into one plan.

The general purposes of the plan are to protect life and property by reducing the potential for future damages and economic losses that result from natural hazards, allow the participating communities to qualify for pre- and post-disaster grant funding, facilitate recovery and redevelopment following disaster events, demonstrate a firm local commitment to hazard mitigation principles, and comply with state and federal requirements for disaster recovery and mitigation funding.

There will be a project kickoff meeting that is open to the public on November 21, 2013 from 10:00 am until noon. The meeting will be held at the Wake County Office Building, 337 S. Salisbury St., Raleigh, NC 27601 in Room G31.

Connect with us:

UPCOMING DATES & EVENTS

11/12/13
Planning Board Meeting

11/19/13
Town Council Meeting

11/28/13
Holiday - Town Offices Closed

12/03/13
Town Council Meeting

12/06/13
Christmas on Salem

More Dates & Events >

Hazard Mitigation Plan

Last Modified: March 17, 2014

The City of Raleigh is participating in the development of a multi-jurisdictional hazard mitigation plan. The Plan will cover Wake County and its 12 municipalities: Apex, Cary, Garner, Holly Springs, Knightdale, Fuquay-Varina, Morrisville, Raleigh, Rolesville, Wake Forest, Wendell, and Zebulon. These local governments will be working together to develop a plan that will help Wake County become more resistant to disasters. The purposes of the plan are to:

- protect life and property by reducing the potential for future damages and economic losses that result from natural hazards;
- allow the participating communities to qualify for pre- and post-disaster grant funding;
- speed recovery and redevelopment following disaster events;
- demonstrate a firm local commitment to hazard mitigation principles; and,
- comply with Federal requirements.

The result of this planning initiative will be a comprehensive, multi-jurisdictional hazard mitigation plan for the county that meets all Federal requirements. The plan will ensure that Wake County and its municipalities are eligible for certain types of State and Federal funding, but more importantly, the plan will include activities that the participating jurisdictions can implement to reduce the impacts of future hazard events.

Per Federal legislation, a FEMA-approved hazard mitigation plan is required for communities to remain eligible for Hazard Mitigation Grant Program (HMGP) funds following a Presidentially declared disaster. A hazard mitigation plan is also required for communities to be eligible for grant funds through FEMA's Pre-Disaster Mitigation (PDM), and Flood Mitigation Assistance (FMA) programs, as well as for Public Assistance for state-declared disasters.

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Police

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- Request a Report
- Animal Control
- Locate a District
- Volunteer Opportunities
- Crime Prevention

Public Safety

Wake County And City Seek Input On Hazard Mitigation Plan

News

City Council Awards Technology Contract for Critical Public Safety Facility (yesterday)

Events

Mar 25 Law and Public Safety Committee Meeting
4:00 pm

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39° High: 51° Low: 30° Wendell, NC

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Current Projects

Multi-Jurisdictional Hazard Mitigation Plan:

The Town of Wendell is working with other Wake County municipalities to become less vulnerable to natural disasters, and your participation in this planning process is important to us! The county, along with local jurisdictions and other partners, are working to prepare a multi-jurisdictional *Hazard Mitigation Plan*. This Plan will identify and assess our community's natural hazard risks and determine how to best minimize or manage those risks. Having an established *Hazard Mitigation Plan* is important to citizens in that it helps to determine flood insurance rates and the ability to apply for recovery funds should the state of North Carolina declare a state disaster. The anticipated draft of the multi-jurisdictional *Hazard Mitigation Plan* is summer 2014.

The survey below will help you share your opinions and participate in the mitigation planning process. The information you provide will help us better understand your hazard concerns and can lead to mitigation activities that should help lessen the impacts of future hazard events. Please take a moment to complete this brief survey.

Public Participation Survey for Hazard Mitigation Planning in Wake County

PLANNING
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Wake County Hazard Mitigation Plan

Public Survey Results

April 21, 2014

Plan Design Enable

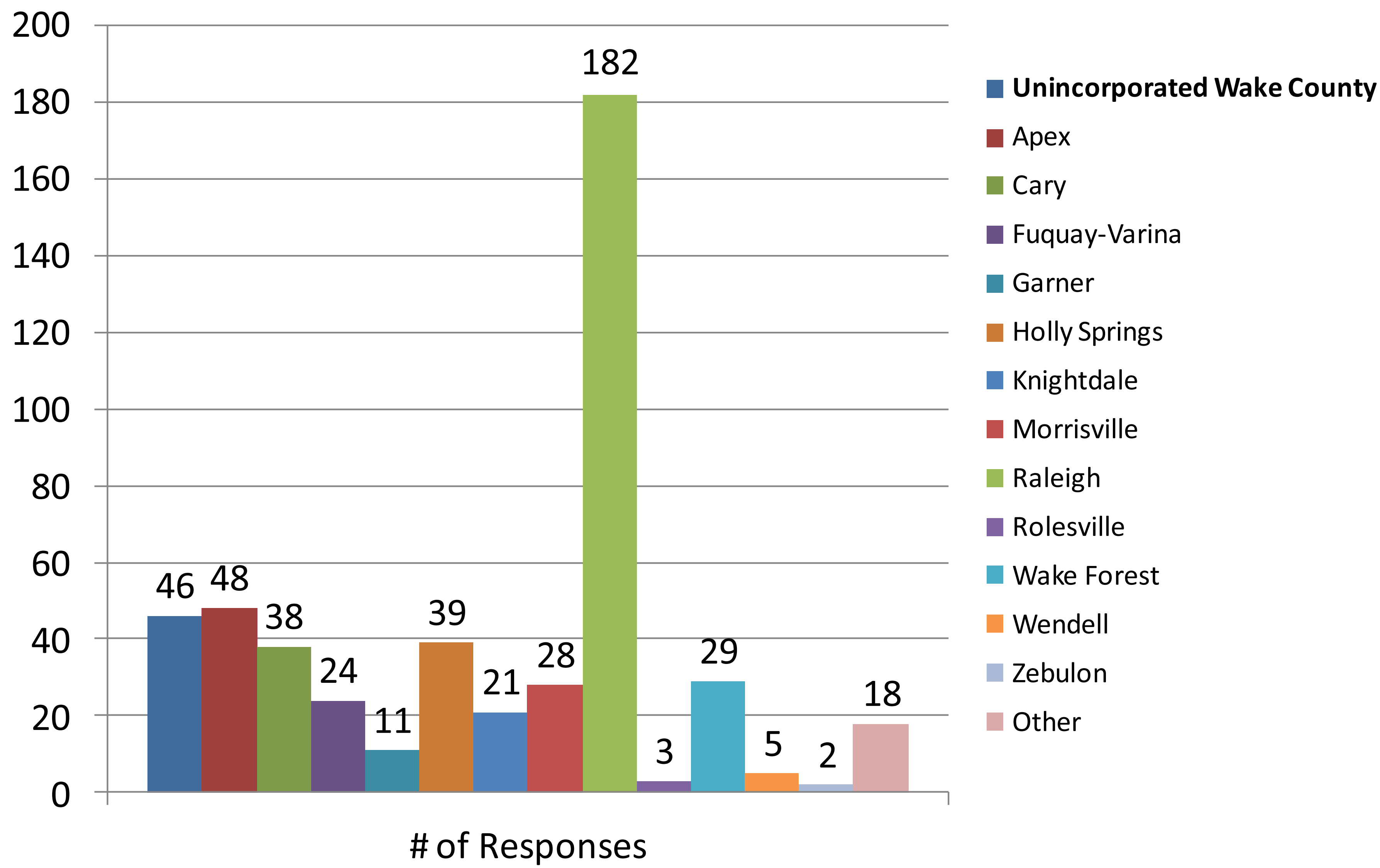
Public Survey

- Provides an opportunity for the public to share opinions and participate in the planning process
- Link to survey posted on County and municipal websites
- WRAL news brief
- 494 completed surveys received
  - 5 were Spanish-translated surveys

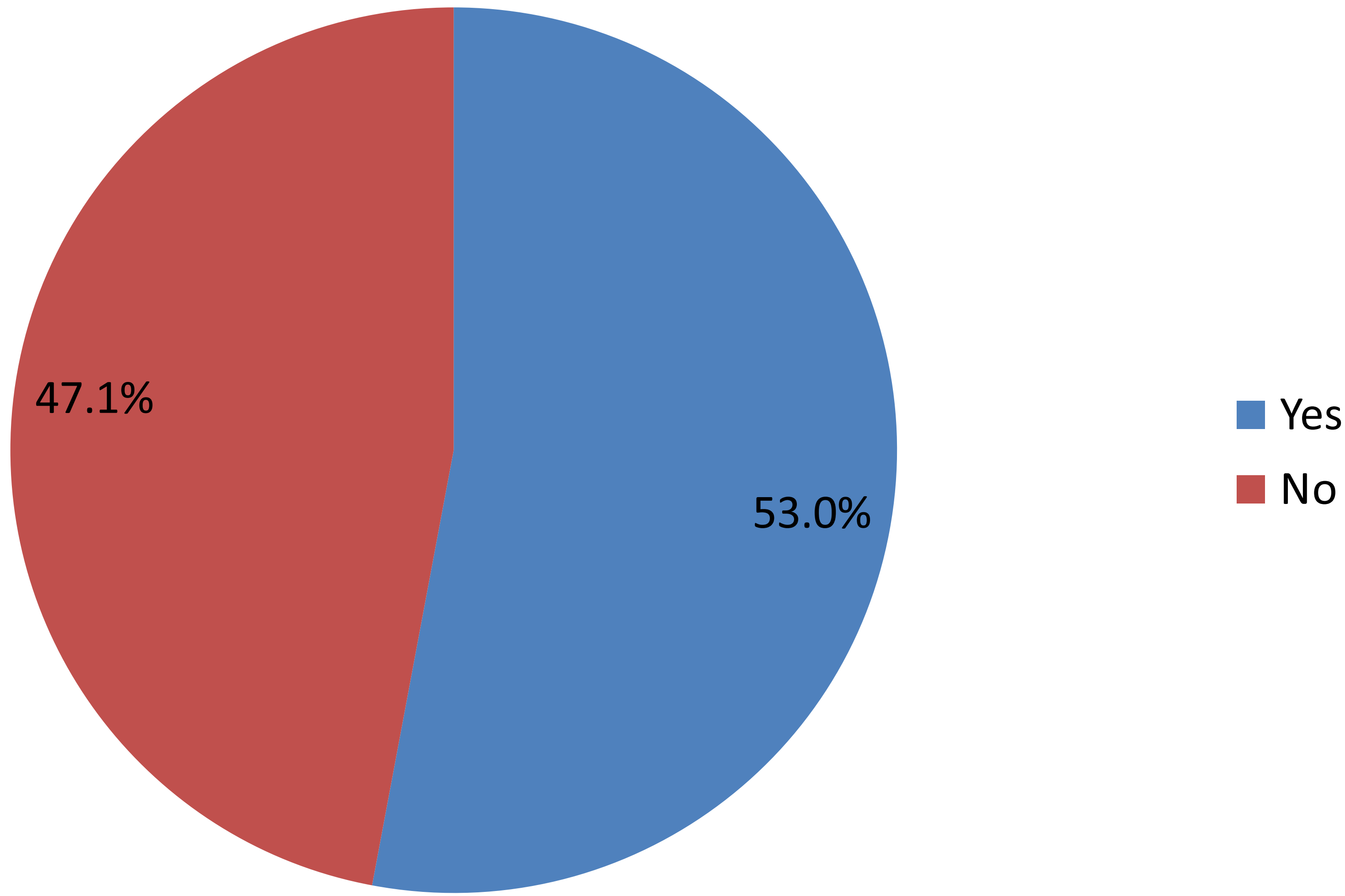
Public Survey Highlights

- 87% of respondents are interested in making their homes more resistant to hazards
- 43% have already taken action to make their homes more hazard resistant
- 74% do not who to contact regarding risk reduction

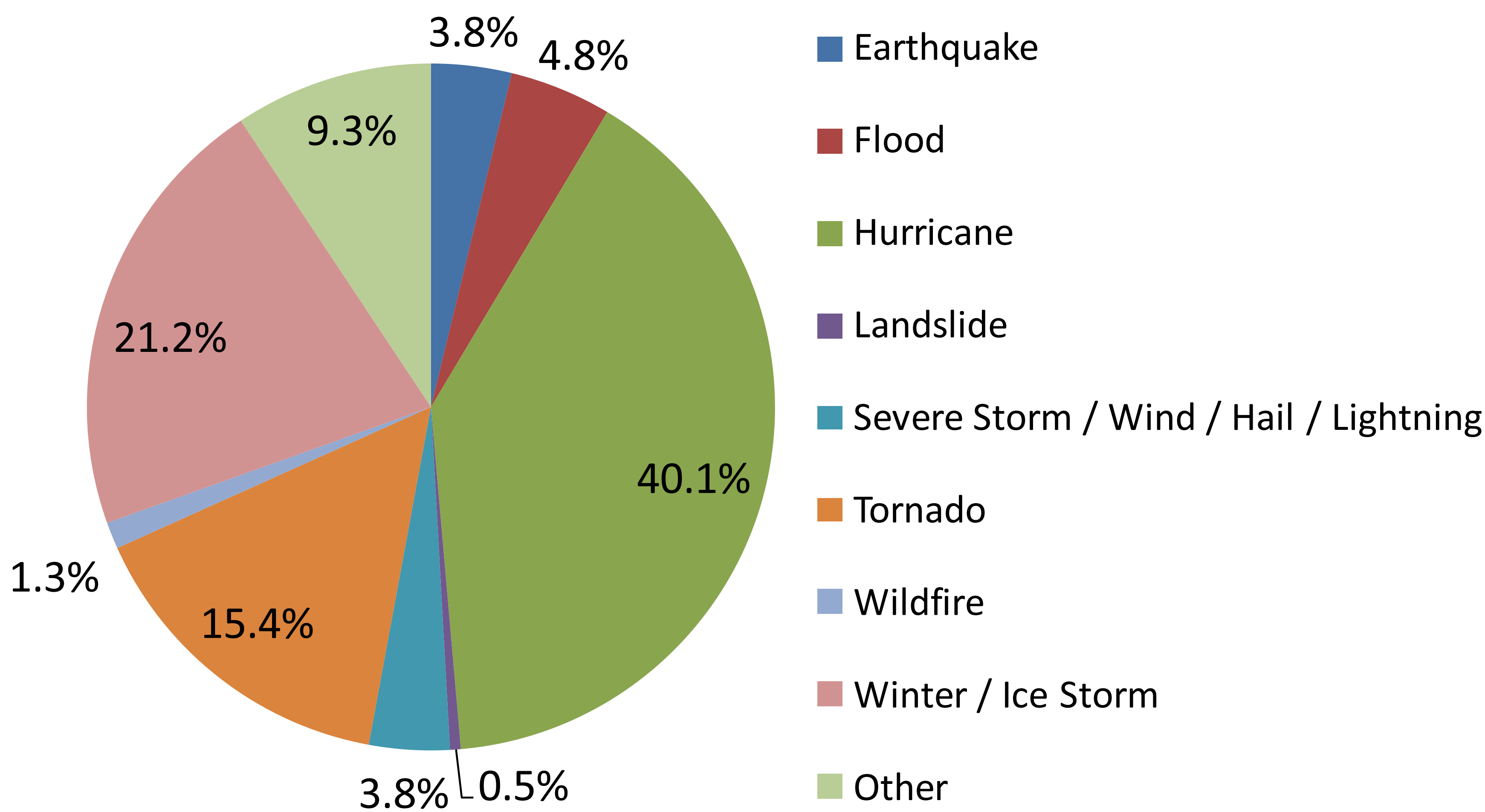
1. Where do you live?



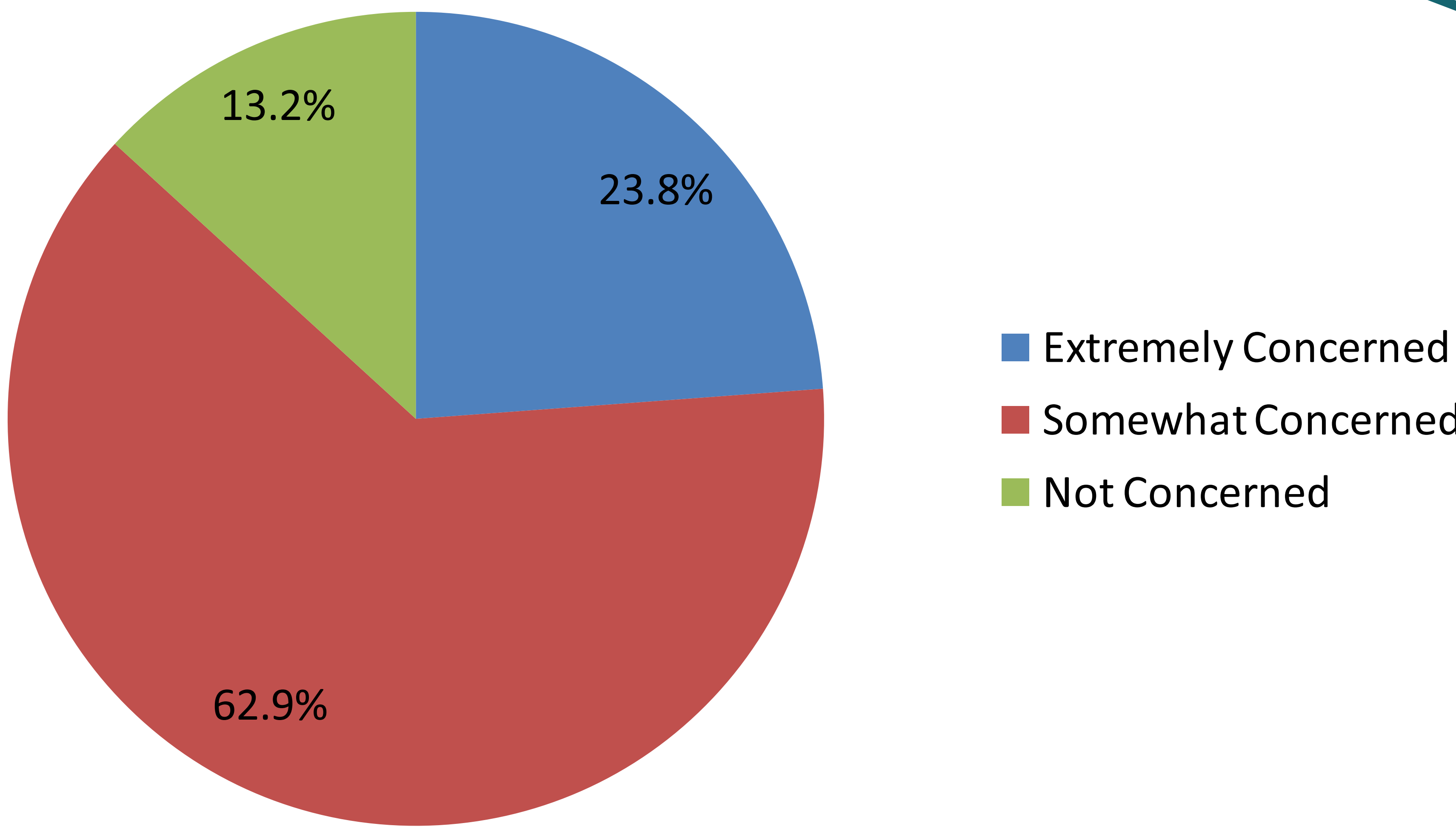
2. Have you experienced a disaster?



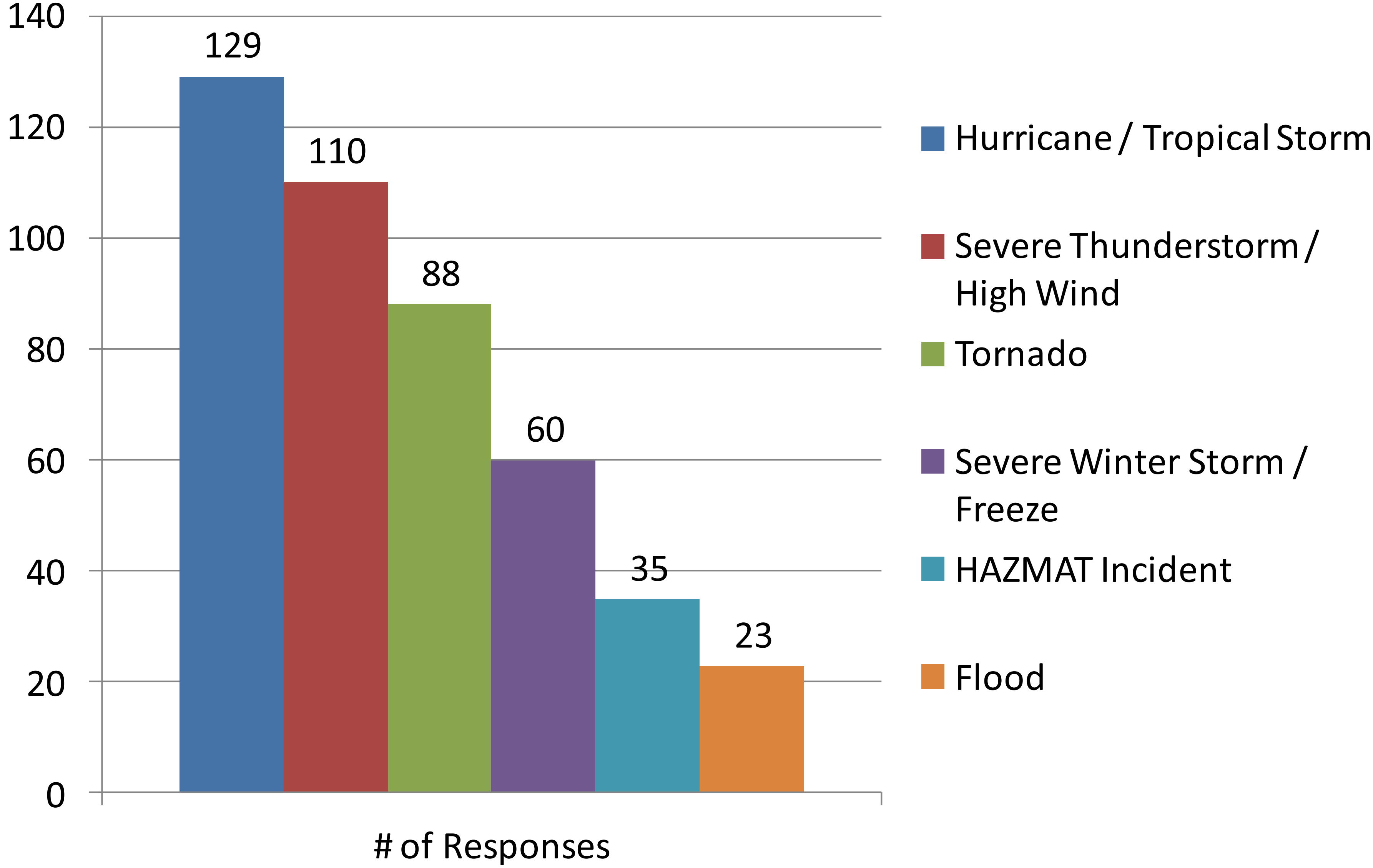
2. Examples of disasters experienced



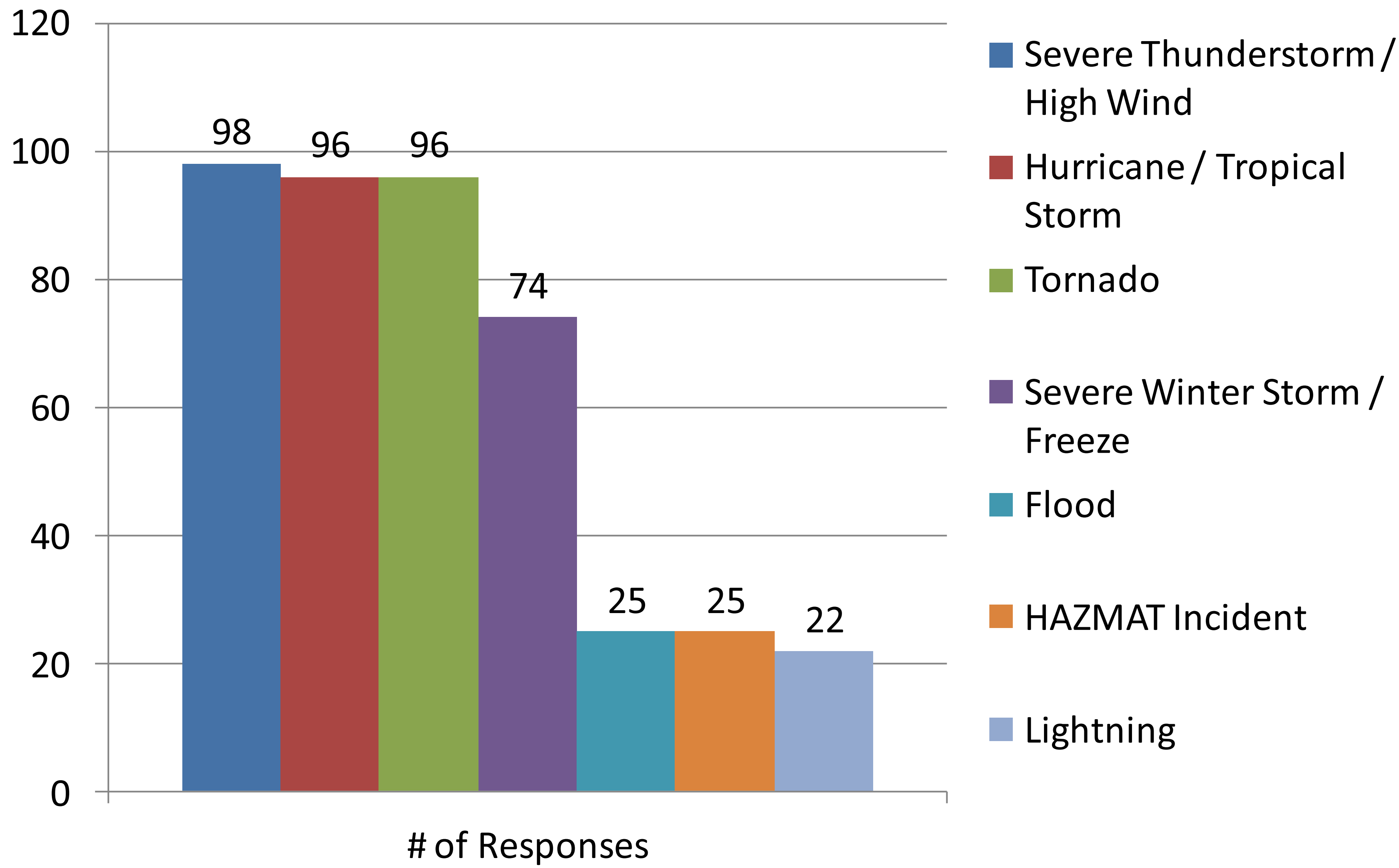
3. How concerned about possibility of disaster?



4. Highest hazard threat?



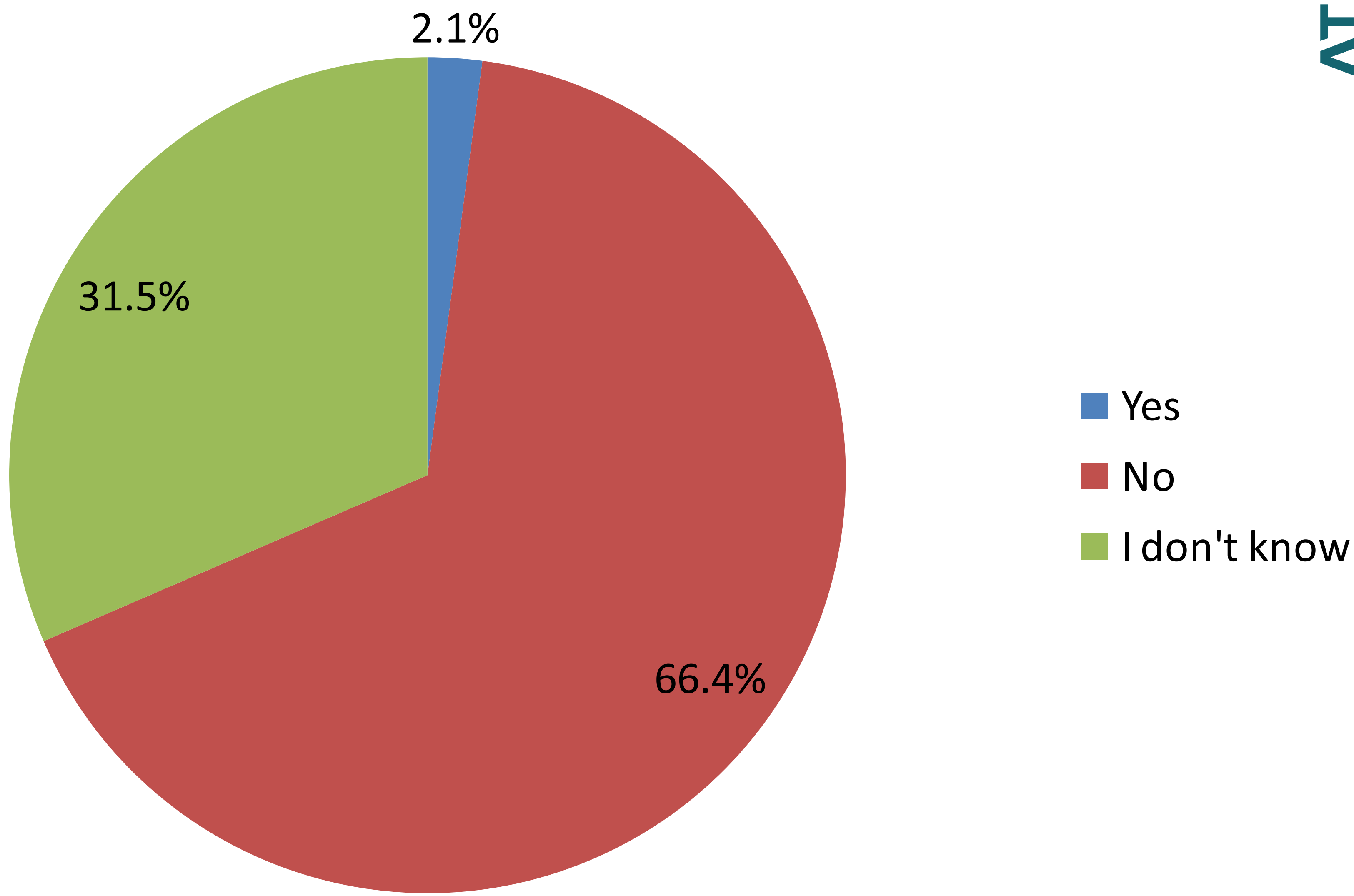
5. Second highest hazard threat?



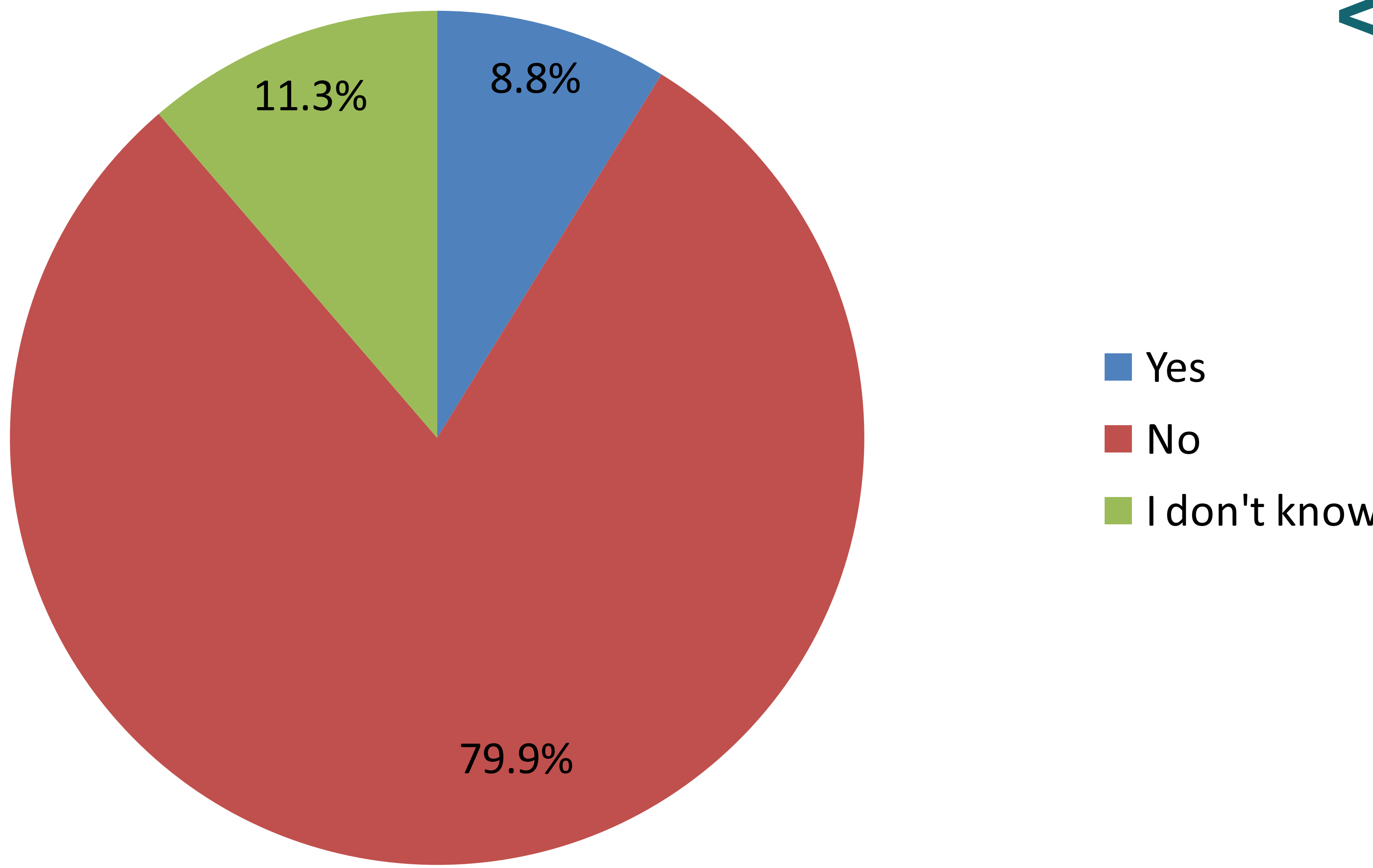
6. Other hazards not listed?

- Shearon Harris Nuclear Plant
- Bioterrorism / Terrorism / Shooting
- Burglary / Crime / Rioting
- Chemical, Biological, Radiological, Nuclear (CBRN)
- Climate Change
- Fracking / Water Contamination / Pollution
- Electromagnetic Pulse / Solar Storm
- Plane Crash
- Power Outage / Failure
- Train Derailment
- Traffic
- Downed Trees
- Leaking Landfill

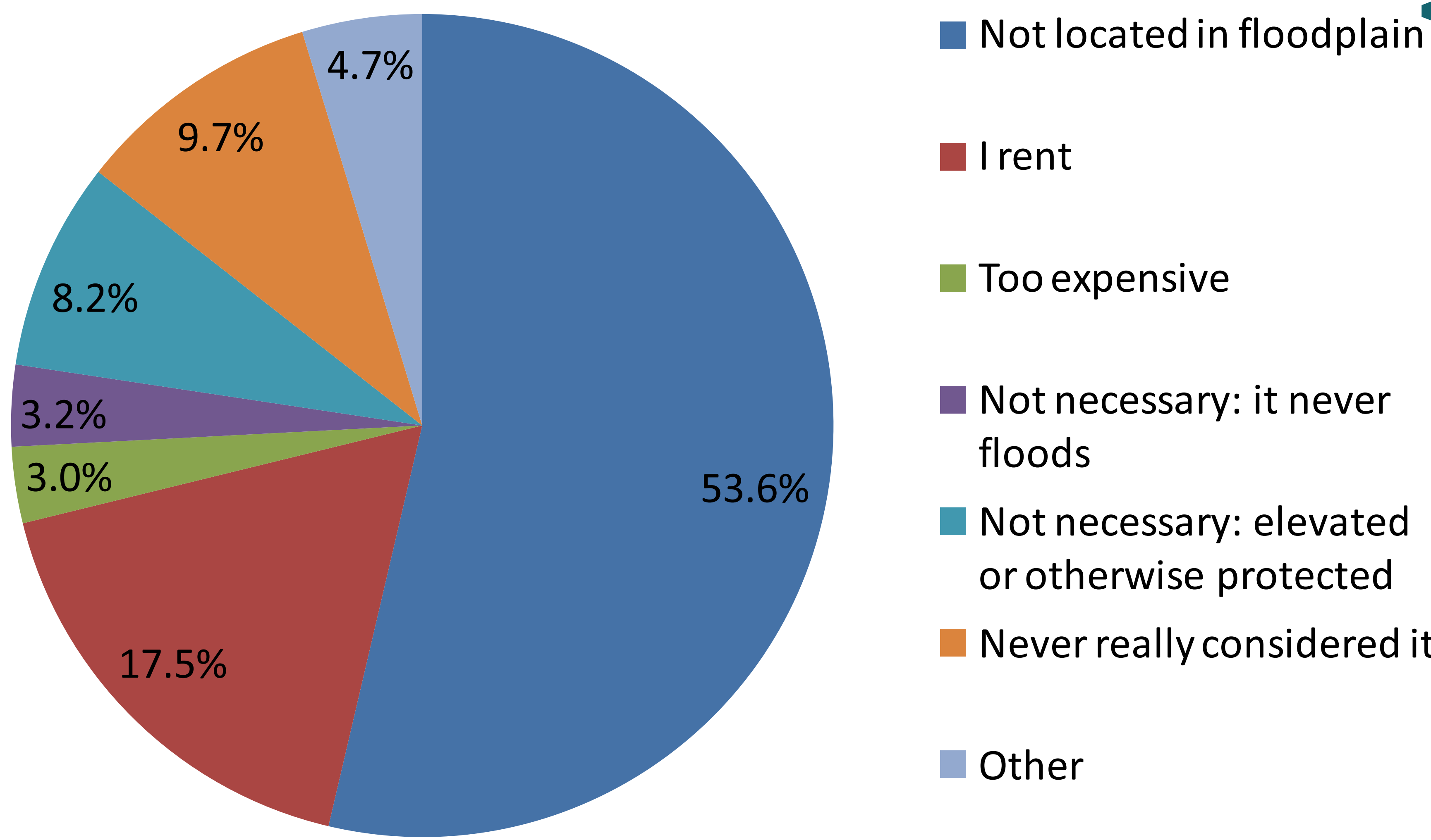
7. Is your home in a FEMA floodplain?



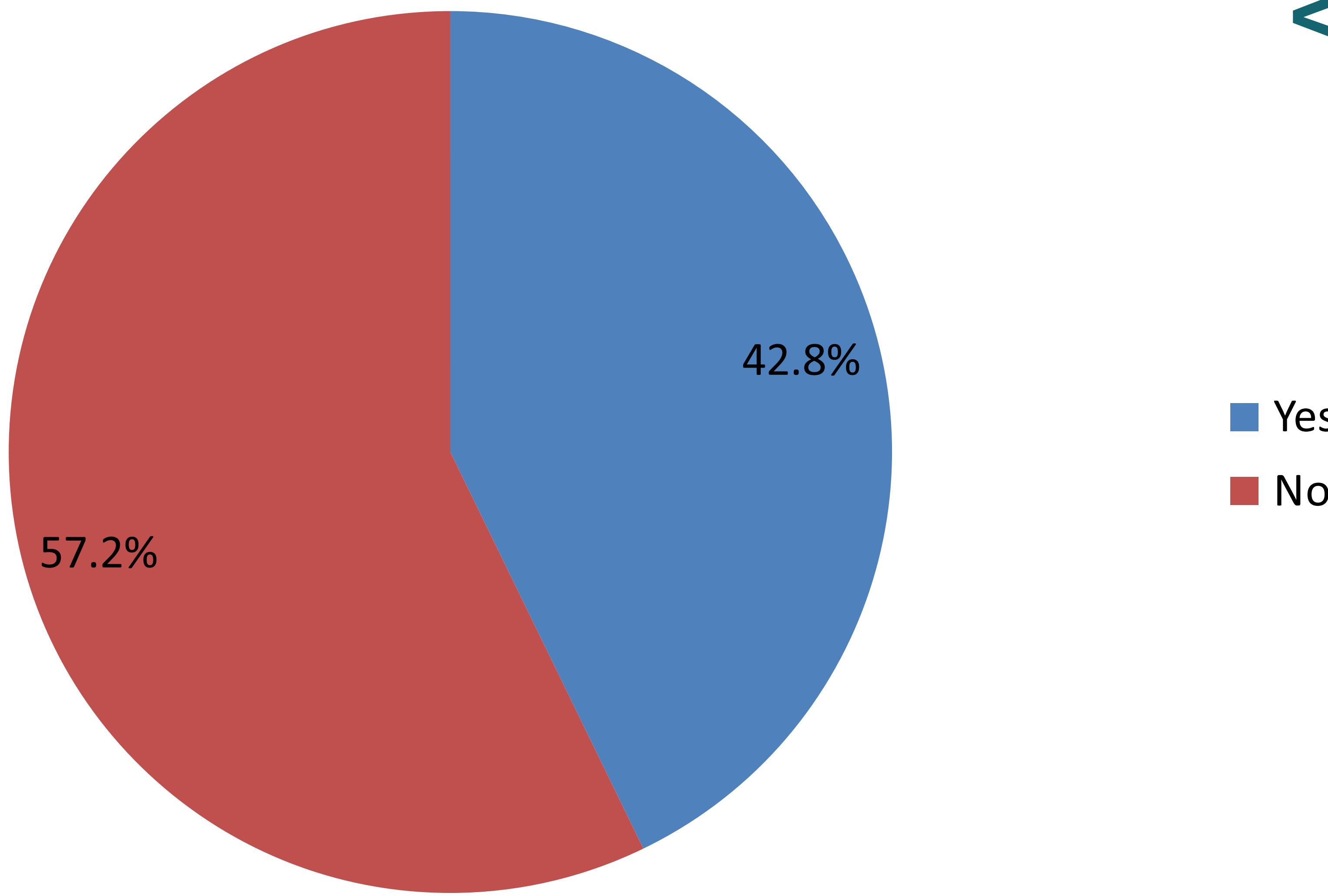
8. Do you have flood insurance?



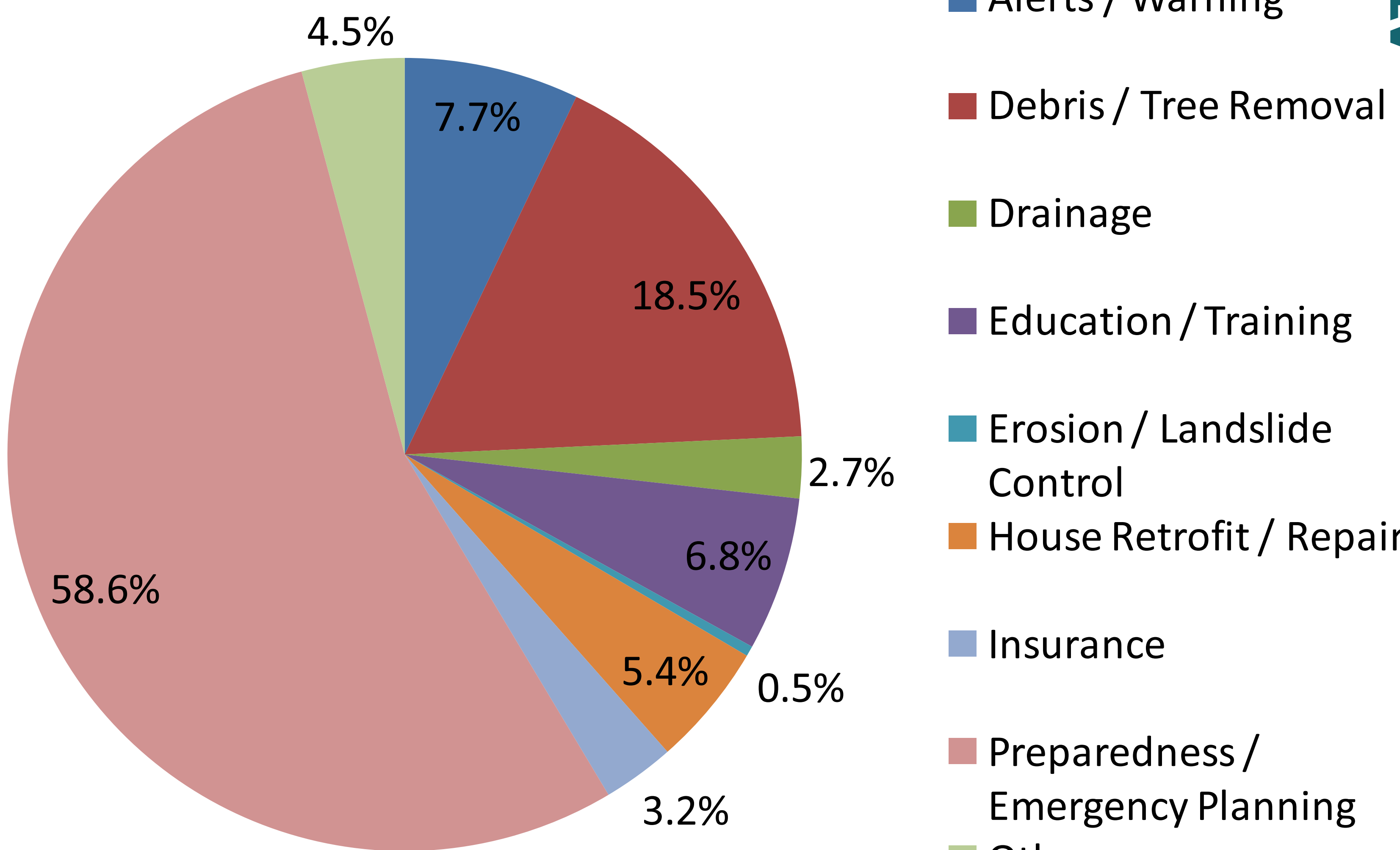
8. Why no flood insurance?



9. Taken action to be more hazard resistant?



9. Examples of actions taken



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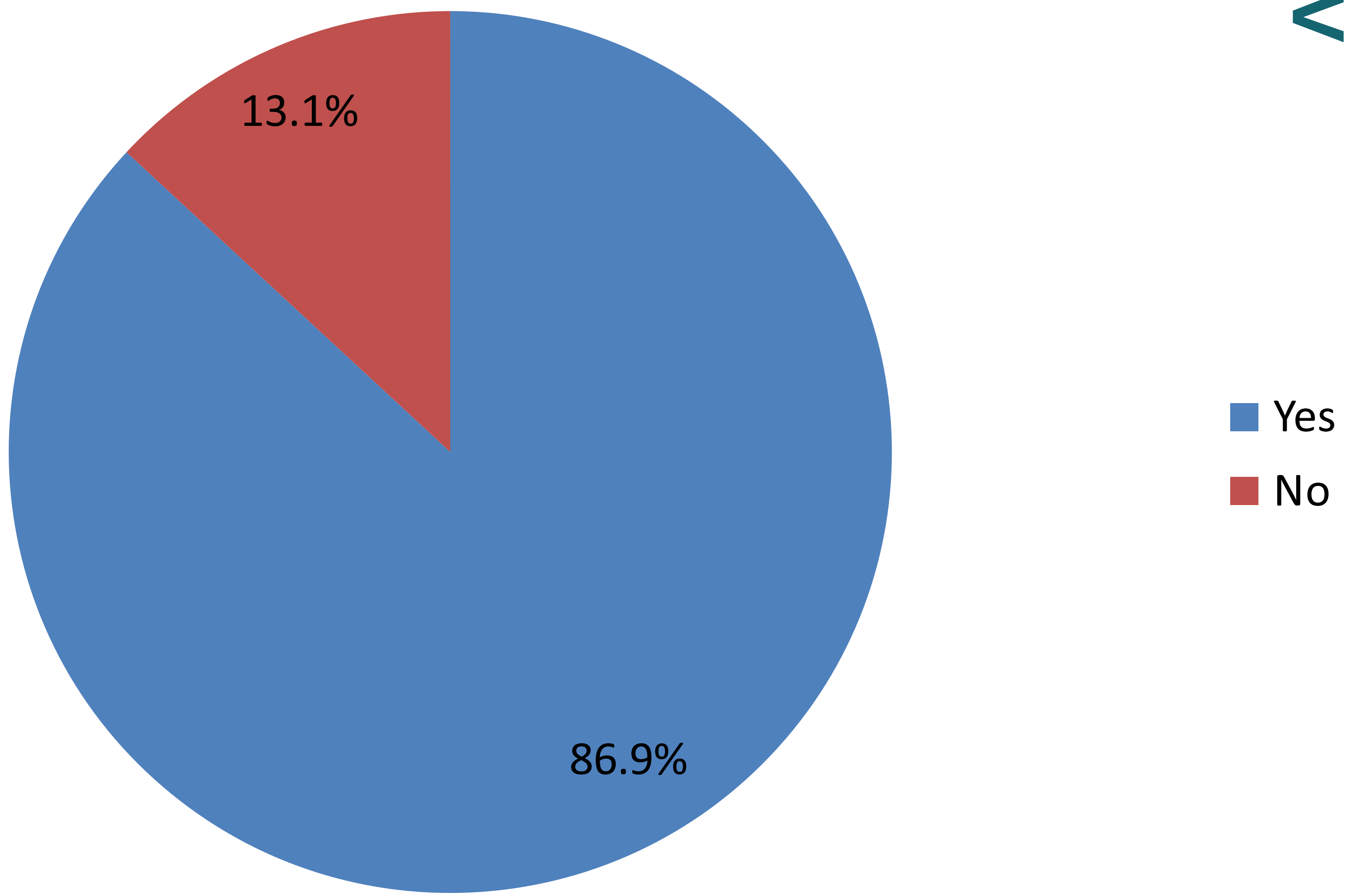
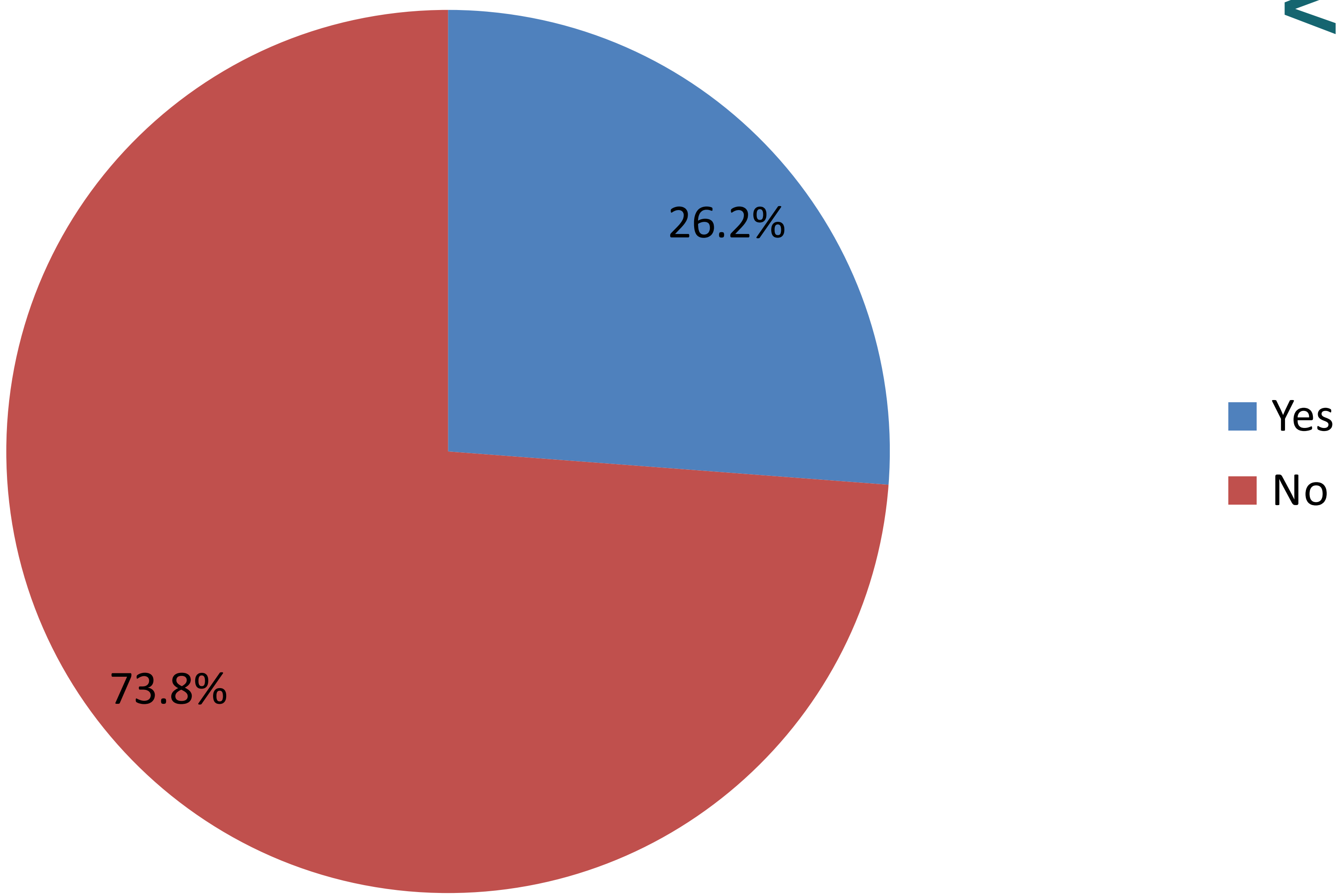
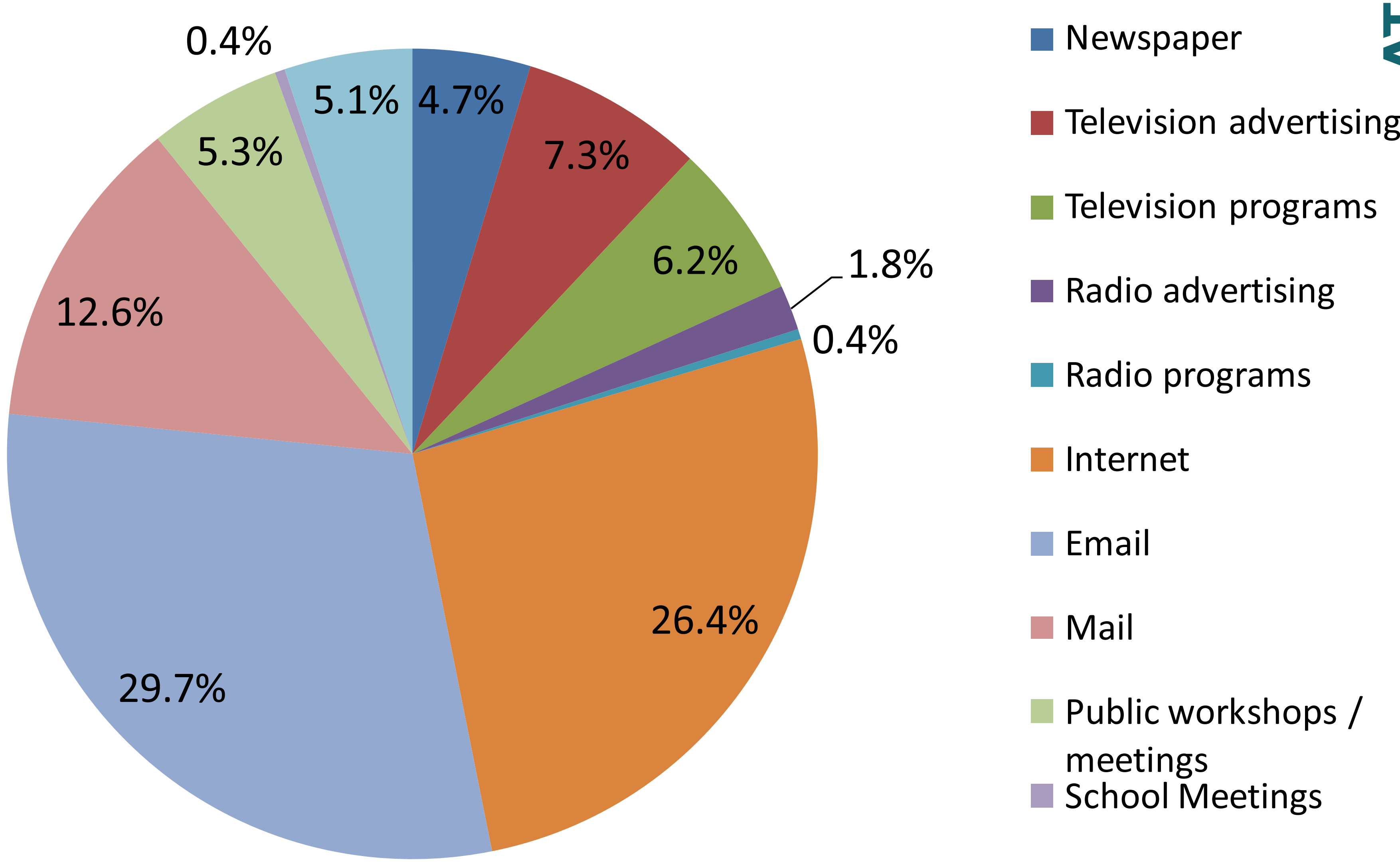
10. Interested in being more hazard resistant?



11. Know who to contact for reducing risks?



12. Most effective way to receive information?



12. Other ways to receive information

- CERT team / training
- Twitter
- Cell phone / text message
- In person
- Audio recording / Braille
- FEMA / Local EM websites
- Local news
- NOAA weather radio
- Professional organizations
- Water bill newsletter
- Town communications
- Information packet

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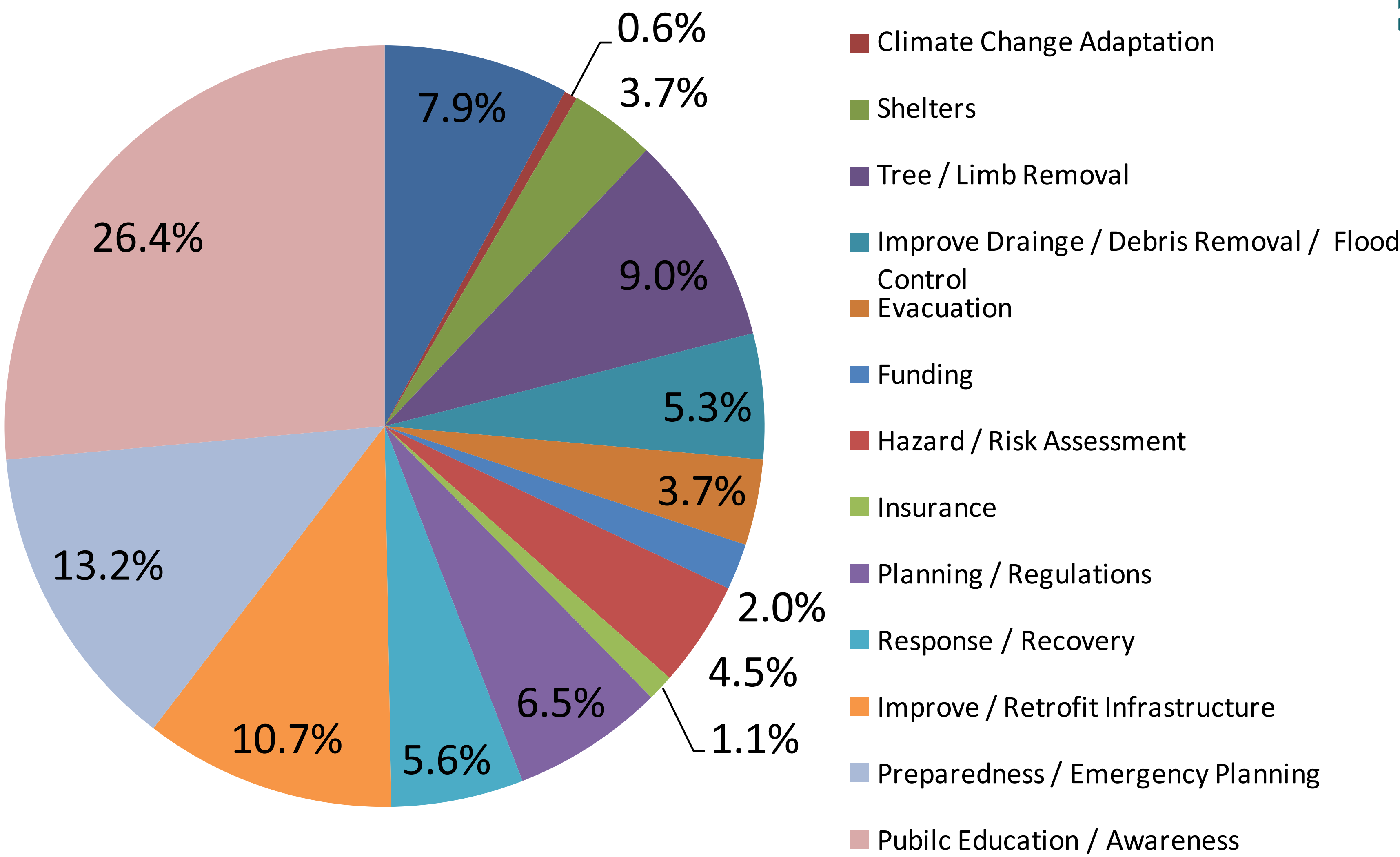
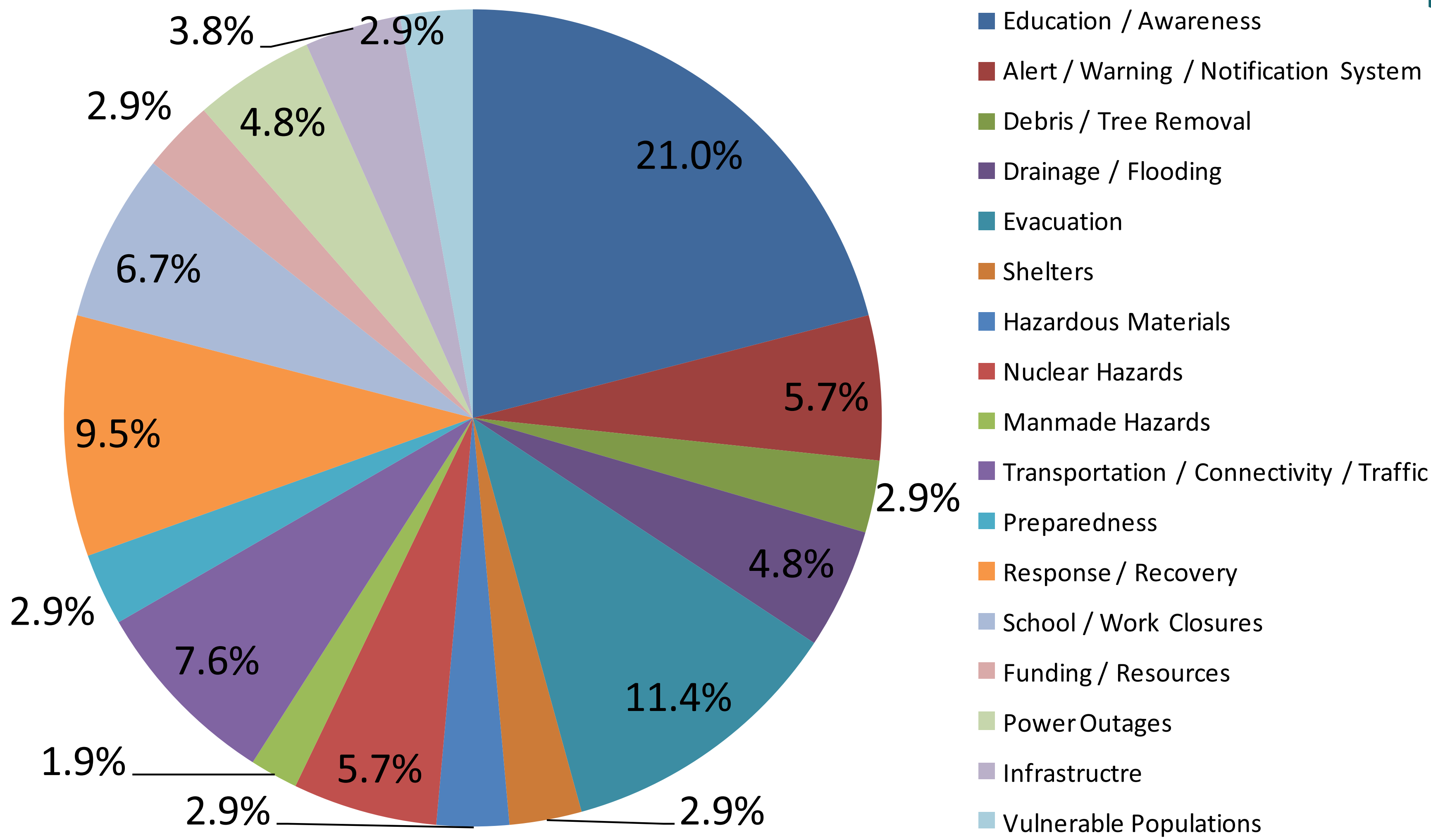
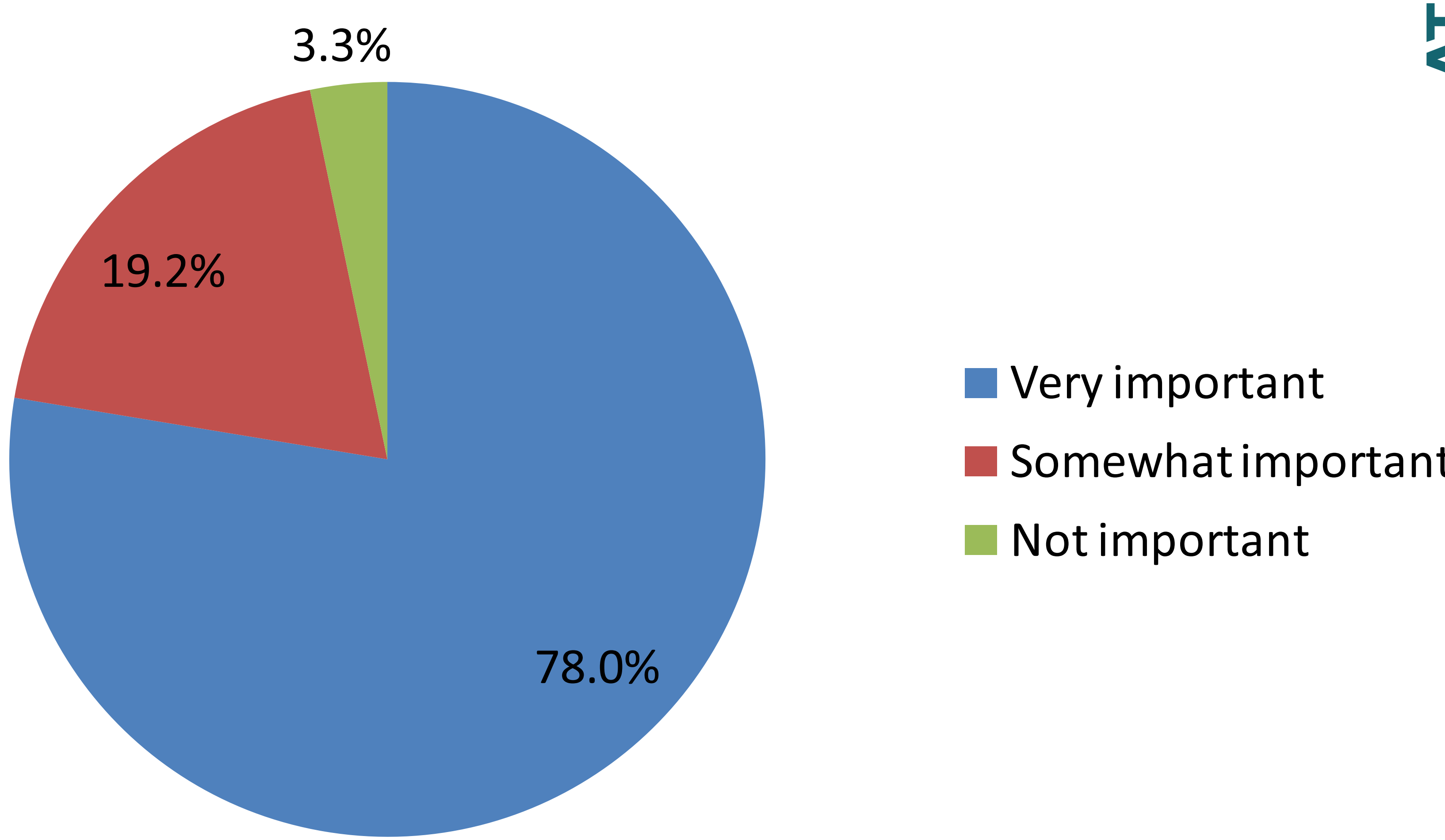
13. Steps local gov't could take to reduce risk



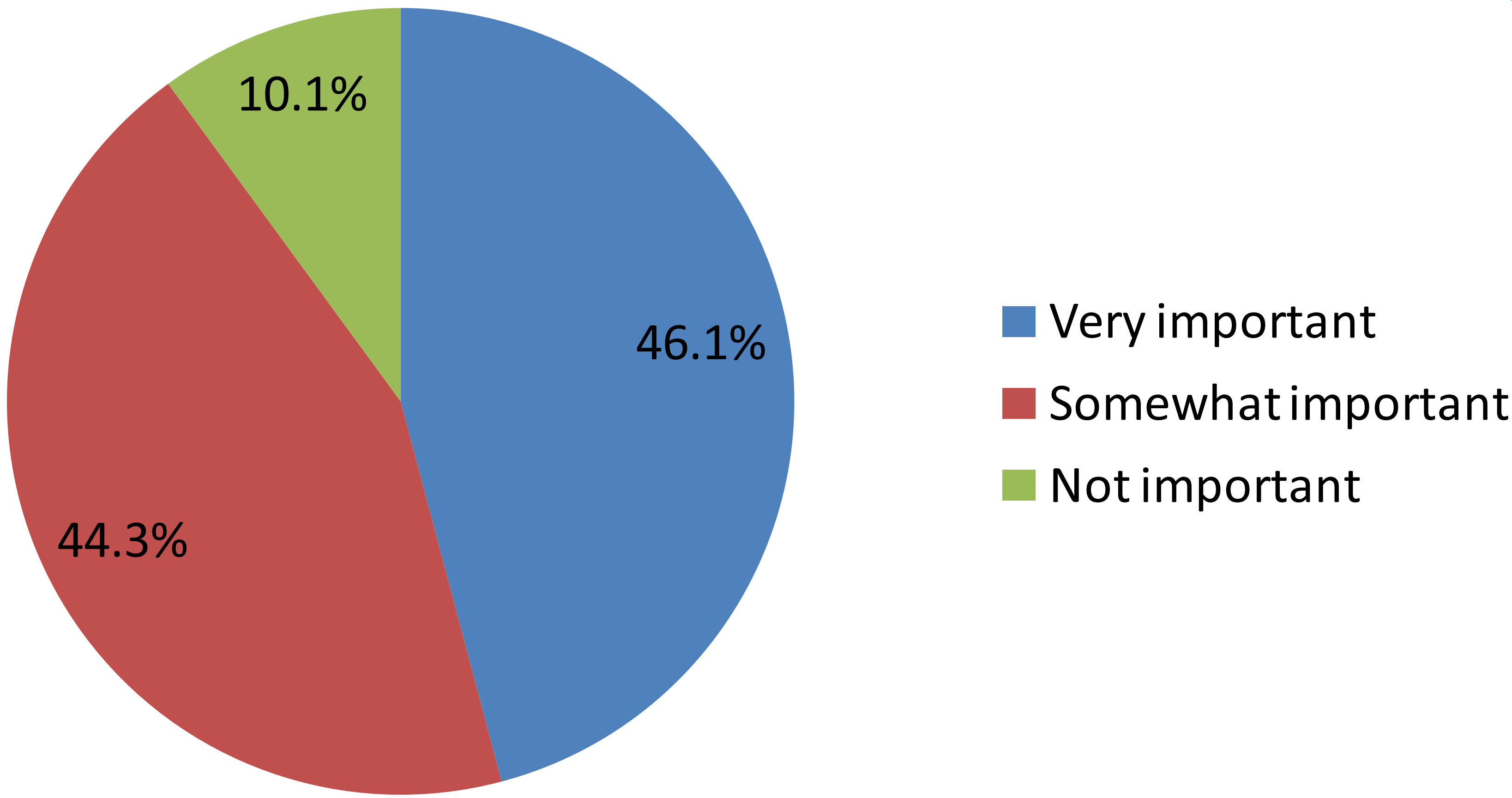
14. Other issues regarding risk and loss



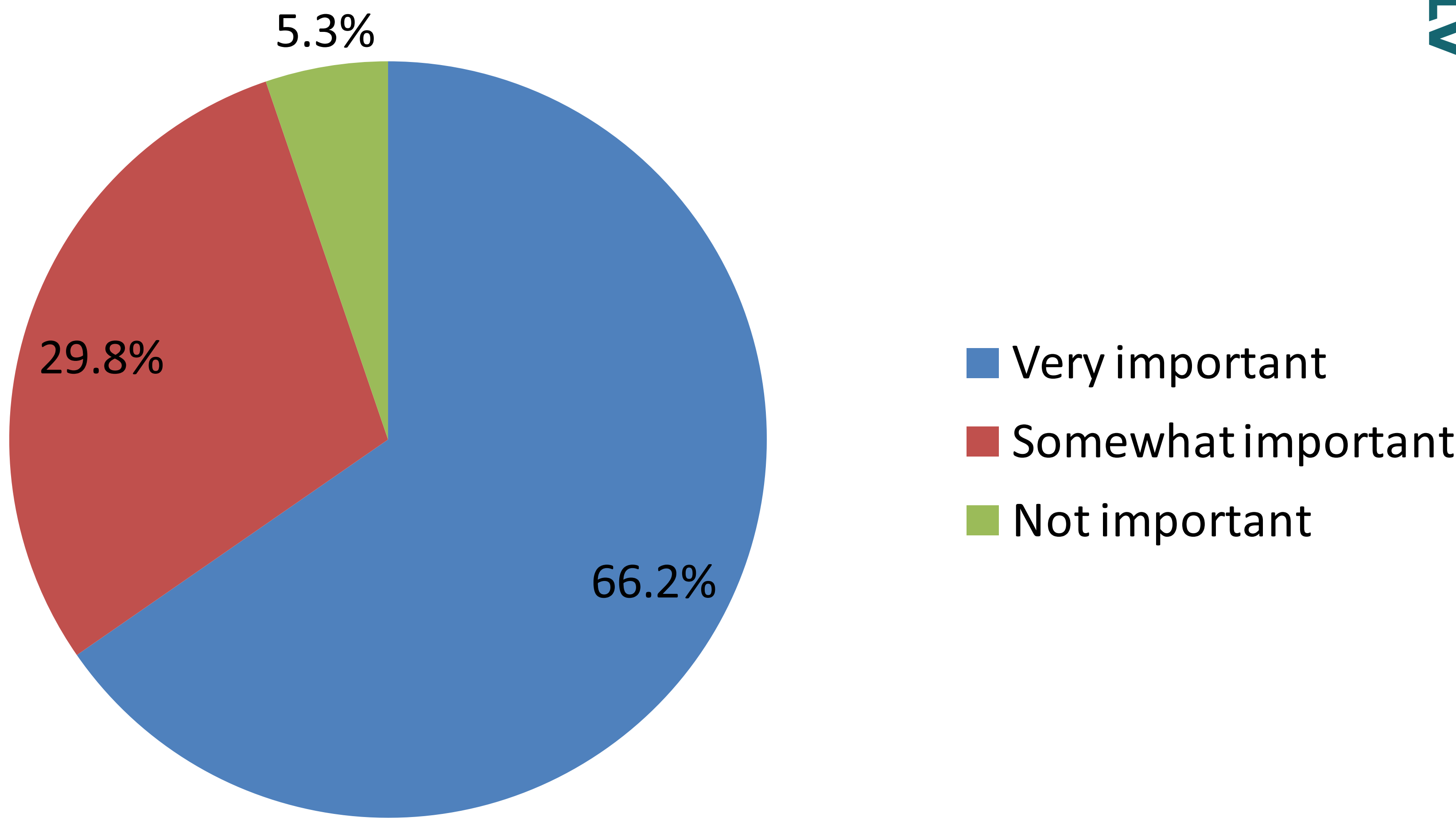
15. Mitigation Actions: Prevention



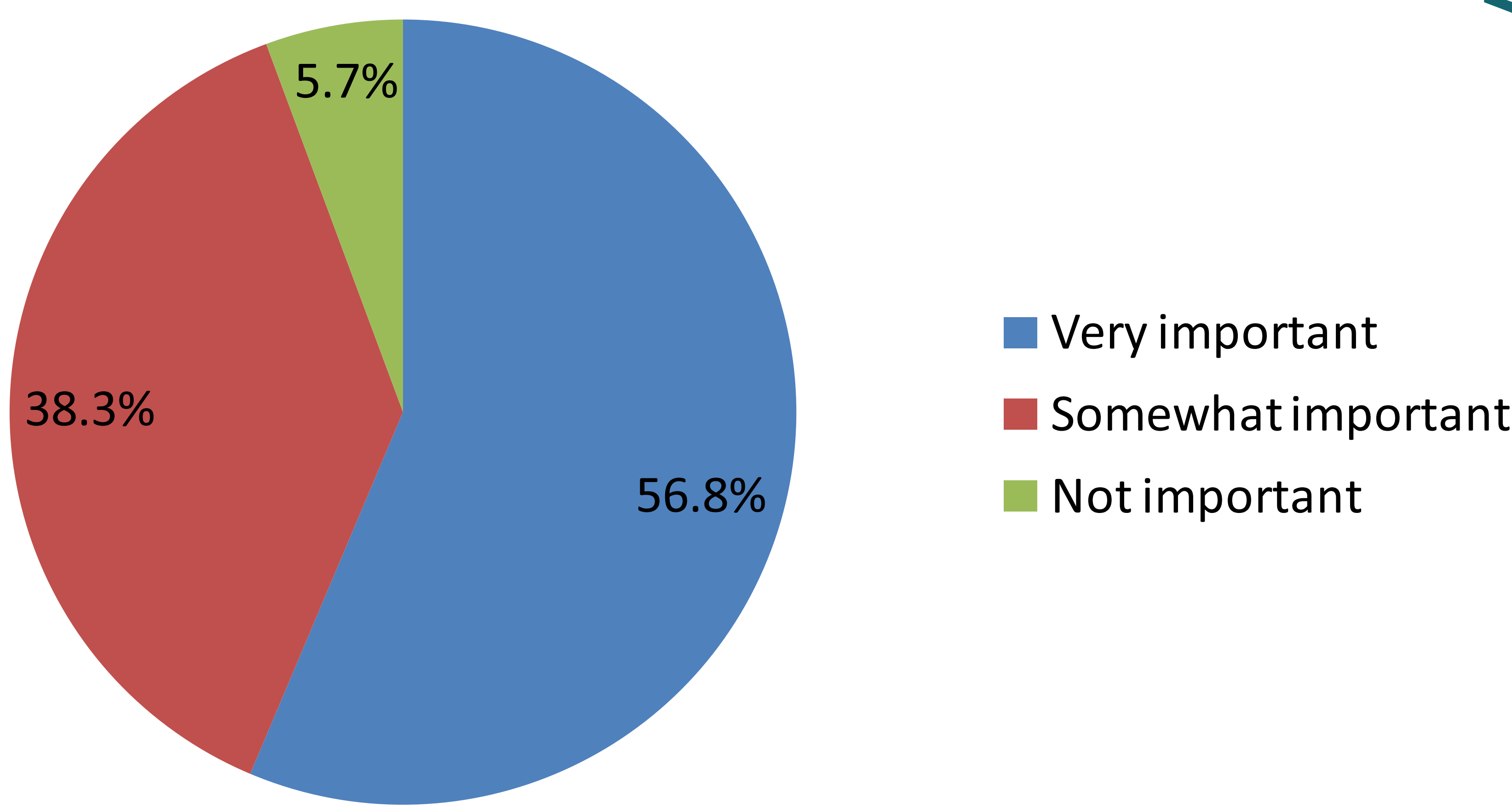
15. Mitigation Actions: Property Protection



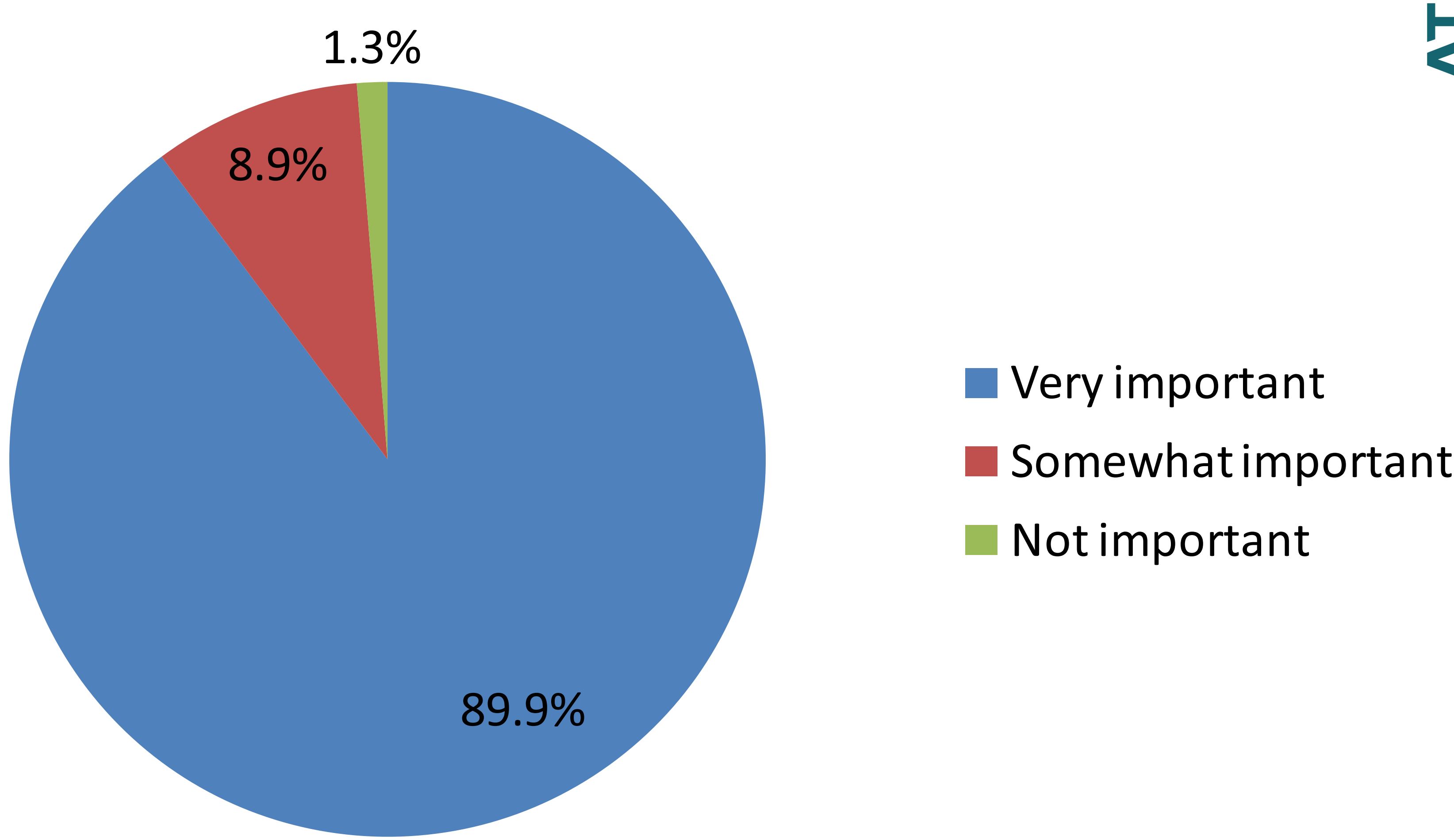
15. Mitigation Actions: Natural Resource Protection



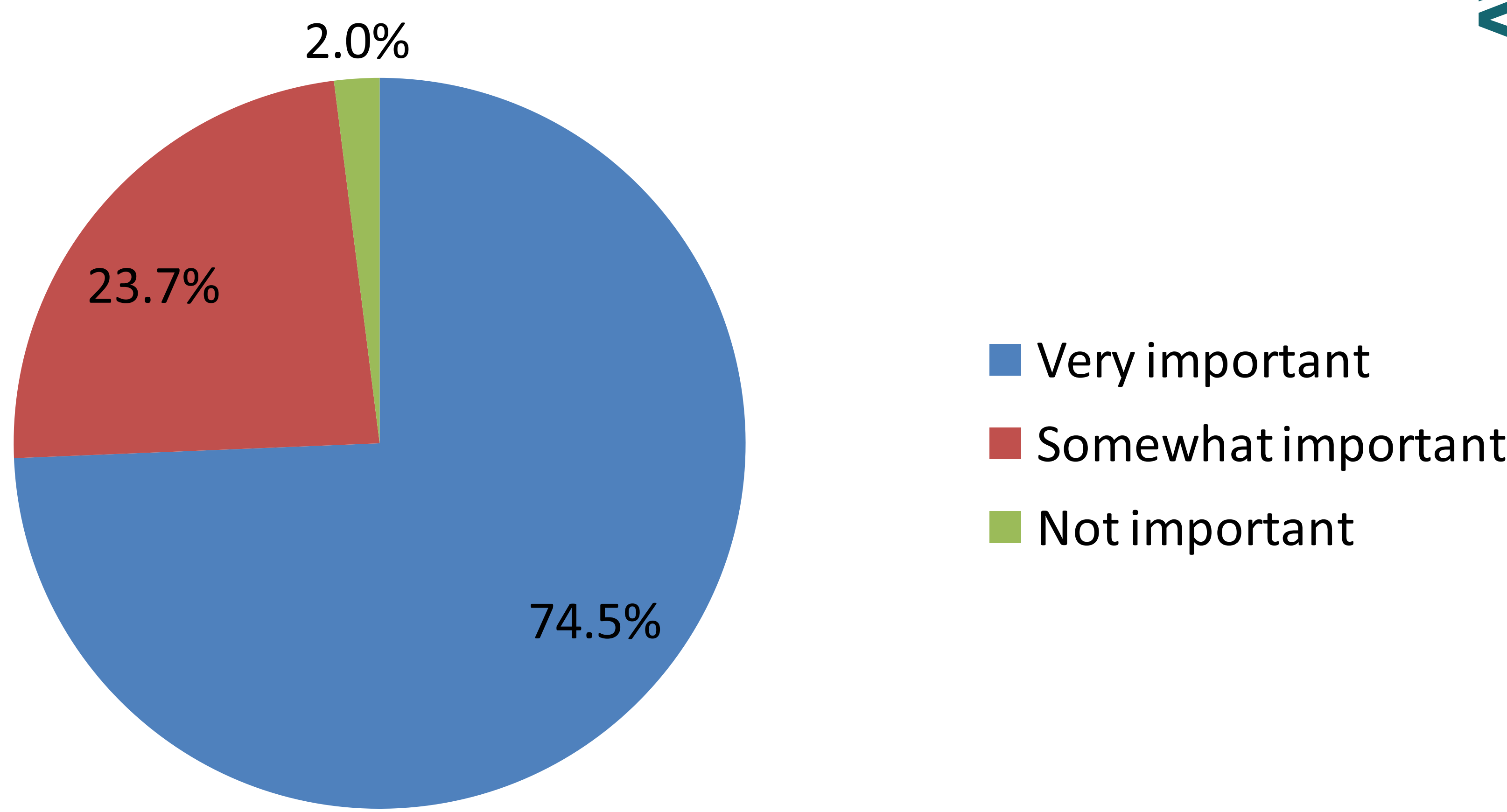
15. Mitigation Actions: Structural Projects



15. Mitigation Actions: Emergency Services



15. Mitigation Actions: Public Education & Awareness



15. Mitigation Actions: Summary

- Highest importance
  - Emergency Services
  - Prevention
- Moderate importance
  - Public Education & Awareness
  - Natural Resource Protection
- Lowest importance
  - Structural Projects
  - Property Protection

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Wake County
Hazard Mitigation Plan

Public Survey Results

April 21, 2014

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