Knox County
Multi-Jurisdictional Local Hazard Mitigation Plan

September 2011

1st Revision: September 2013

2nd Revision: September 2014

Developed by Knox County with professional planning assistance from
AMEC Earth and Environmental
Homeland Security and Emergency Management

SPECIAL THANKS AND ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The purpose of natural hazards mitigation is to reduce or eliminate long-term risk to people and property from natural hazards. Knox County and participating jurisdictions developed this multi-jurisdictional local hazard mitigation plan to reduce future losses to the County and its communities resulting from natural hazards. The plan was prepared pursuant to the requirements of the Disaster Mitigation Act of 2000 and to achieve eligibility for the Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance Grant Programs.

The Knox County Multi-Hazard Mitigation Plan is a multi-jurisdictional plan that covers the following local governments that participated in the planning process:

- Knox County
- City of Knoxville
- Town of Farragut

The County's planning process followed a methodology prescribed by FEMA, which began with the formation of a Hazard Mitigation Planning Committee (HMPC) comprised of key stakeholders from Knox County and participating jurisdictions. The HMPC conducted a risk assessment that identified and profiled hazards that pose a risk to Knox County, assessed the County's vulnerability to these hazards, and examined the capabilities in place to mitigate them. The County is vulnerable to several hazards that are identified, profiled, and analyzed in this plan. Floods, winter storms, landslides and windstorms are among the hazards that can have a significant impact on the County.

Based upon the risk assessment, the HMPC identified goals for reducing risk from hazards. Goals Developed by the Hazard Mitigation Planning Committee are listed below:

- Minimize, prevent or reduce the vulnerability of the people, property, environment, and economy of Knox County, City of Knoxville and Town of Farragut to the impacts of natural hazards.

- Increase citizen awareness and preparedness by providing information describing all types of hazards, methods for preventing damage, and how to respond.

- Protect critical facilities and infrastructure from natural hazards.

- Create a disaster resistant community by involving elected officials, individuals in the private and public sector to participate in hazard mitigation planning and

training activities geared towards reducing the impact of disasters in Knox County, City of Knoxville, and Town of Farragut.

To meet the identified goals, the plan recommends the mitigation actions detailed in Chapter 4. The HMPC developed an implementation plan for each action, which identifies priority level, background information, ideas for implementation, responsible agency, timeline, cost estimate, potential funding sources, and more. These additional details are also provided in Chapter 4.

PREREQUISITES

44 CFR requirement 201.6(c)(5): The local hazard mitigation plan shall include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan. For multi-jurisdictional plans, each jurisdiction requesting approval of the plan must document that it has been formally adopted.

***Note to Reviewers**: When this plan has been reviewed and approved pending adoption by FEMA Region IV the adoption resolutions will be signed by the participating jurisdictions and added to Appendix D. A model resolution is provided.*

The following jurisdictions participated in the development of this plan and have adopted the multi-jurisdictional plan. Resolutions of Adoptions are included in Appendix D.

- Knox County
- City of Knoxville
- Town of Farragut

Model Resolution

Resolution # _____ **Adopting the Knox County Multi-Jurisdictional Local Hazard Mitigation Plan**

Whereas, the (Name of Government/District/Organization seeking FEMA approval of hazard mitigation plan) recognizes the threat that natural hazards pose to people and property within our community; and

Whereas, undertaking hazard mitigation actions will reduce the potential for harm to people and property from future hazard occurrences; and

Whereas, the U.S Congress passed the Disaster Mitigation Act of 2000 ("Disaster Mitigation Act") emphasizing the need for pre-disaster mitigation of potential hazards;

Whereas, the Disaster Mitigation Act made available hazard mitigation grants to state and local governments; and

Whereas, an adopted Local Hazard Mitigation Plan is required as a condition of future funding for mitigation projects under multiple FEMA pre- and post-disaster mitigation grant programs; and

Whereas, the (Name of Government/District/Organization) fully participated in the FEMA-prescribed mitigation planning process to prepare this Multi-Jurisdictional Local Hazard Mitigation Plan; and

Whereas, the Tennessee Emergency Management Agency and the Federal Emergency Management Agency Region IV officials have reviewed the "Knox County Multi-Jurisdictional Local Hazard Mitigation Plan," and approved it contingent upon this official adoption of the participating governing body; and

Whereas, the (Name of Government/District/Organization) desires to comply with the requirements of the Disaster Mitigation Act and to augment its emergency planning efforts by formally adopting the Knox County Multi-Jurisdictional Local Hazard Mitigation Plan; and

Whereas, adoption by the governing body for the (Name of Government/District/Organization) demonstrates the jurisdictions' commitment to fulfilling the mitigation goals and objectives outlined in this Multi-Jurisdictional Local Hazard Mitigation Plan

Whereas, adoption of this legitimizes the plan and authorizes responsible agencies to carry out their responsibilities under the plan;

Now, therefore, be it resolved, that the (Name of Government/District/Organization) adopts the "Knox County Multi-Jurisdictional Local Hazard Mitigation Plan" as an official plan; and

Be it further resolved, the (Name of Government/District/Organization) will submit this Adoption Resolution to the Tennessee Emergency Management Agency and Federal Emergency Management Agency Region IV officials to enable the plan's final approval.

Date: _____

Certifying Official: _____

1 INTRODUCTION AND PLANNING PROCESS

1.1 Purpose

Knox County and three other jurisdictions prepared this local hazard mitigation plan to guide hazard mitigation planning to better protect the people and property of the County from the effects of hazard events. This plan demonstrates the communities' commitment to reducing risks from hazards and serves as a tool to help decision makers direct mitigation activities and resources. This plan was also developed to make Knox County and participating jurisdictions eligible for certain federal disaster assistance, specifically, the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Assistance grants such as the Hazard Mitigation Grant Program, Pre-Disaster Mitigation program, and Flood Mitigation Assistance program.

1.2 Background and Scope

Each year in the United States, natural disasters take the lives of hundreds of people and injure thousands more. Nationwide, taxpayers pay billions of dollars annually to help communities, organizations, businesses, and individuals recover from disasters. These monies only partially reflect the true cost of disasters, because additional expenses to insurance companies and nongovernmental organizations are not reimbursed by tax dollars. Many natural disasters are predictable, and much of the damage caused by these events can be alleviated or even eliminated.

Hazard mitigation is defined by FEMA as "any sustained action taken to reduce or eliminate long-term risk to human life and property from a hazard event." The results of a three-year, congressionally mandated independent study to assess future savings from mitigation activities provides evidence that mitigation activities are highly cost-effective. On average, each dollar spent on mitigation saves society an average of $4 in avoided future losses in addition to saving lives and preventing injuries (National Institute of Building Science Multi-Hazard Mitigation Council 2005).

Hazard mitigation planning is the process through which hazards that threaten communities are identified, likely impacts of those hazards are determined, mitigation goals are set, and appropriate strategies to lessen impacts are determined, prioritized, and implemented. This plan documents Knox County's hazard mitigation planning process and identifies relevant hazards, vulnerabilities, and strategies the County and participating jurisdictions will use to decrease vulnerability and increase resiliency and sustainability in Knox County.

The Knox County Multi-Jurisdictional Local Hazard Mitigation Plan is a multi-jurisdictional plan that geographically covers the participating jurisdictions within Knox County's boundaries (hereinafter referred to as the planning area). The following four jurisdictions participated in the planning process:

- Knox County
- City of Knoxville
- Town of Farragut

This plan was prepared pursuant to the requirements of the Disaster Mitigation Act of 2000 (Public Law 106-390) and the implementing regulations set forth by the Interim Final Rule published in the *Federal Register* on February 26, 2002, (44 CFR §201.6) and finalized on October 31, 2007. (Hereafter, these requirements and regulations will be referred to collectively as the Disaster Mitigation Act.) While the act emphasized the need for mitigation plans and more coordinated mitigation planning and implementation efforts, the regulations established the requirements that local hazard mitigation plans must meet in order for a local jurisdiction to be eligible for certain federal disaster assistance and hazard mitigation funding under the Robert T. Stafford Disaster Relief and Emergency Act (Public Law 93-288).

Information in this plan will be used to help guide and coordinate mitigation activities and decisions for local land use policy in the future. Proactive mitigation planning will help reduce the cost of disaster response and recovery to communities and their residents by protecting critical community facilities, reducing liability exposure, and minimizing overall community impacts and disruptions. The Knox County planning area has been affected by hazards in the past and the participating jurisdictions are therefore committed to reducing future impacts from hazard events and becoming eligible for mitigation-related federal funding.

1.3 Plan Organization

The Knox County Multi-Jurisdictional Local Hazard Mitigation Plan is organized as follows:

- Executive Summary
- Prerequisites
- Chapter 1: Introduction and Planning Process
- Chapter 2: Planning Area Profile and Capabilities
- Chapter 3: Risk Assessment
- Chapter 4: Mitigation Strategy
- Chapter 5: Plan Implementation and Maintenance
- Appendices

1.4 Planning Process

44 CFR Requirement 201.6(c)(1): [The plan shall document] 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.

In July 2010, Knox County contracted with AMEC Earth and Environmental (AMEC) to facilitate the development of a multi-jurisdictional, local hazard mitigation plan. AMEC's role was to:

- Assist in establishing the Hazard Mitigation Planning Committee (HMPC) as defined by the Disaster Mitigation Act (DMA),
- Ensure the developed plan meets the DMA requirements as established by federal regulations and following FEMA's planning guidance,
- Facilitate the entire planning process,
- Identify the data requirements that HMPC participants could provide and conduct the research and documentation necessary to augment that data,
- Assist in facilitating the public input process,
- Produce the draft and final plan documents, and
- Coordinate the Tennessee Emergency Management Agency and FEMA plan reviews.

1.4.1 Multi-Jurisdictional Participation

44 CFR Requirement §201.6(a)(3): Multi-jurisdictional plans may be accepted, as appropriate, as long as each jurisdiction has participated in the process and has officially adopted the plan.

Knox County Emergency Management invited the two incorporated cities, the school district, various county and city departments, fire department personnel, library representatives, and state agencies to participate in the Knox County Multi-Jurisdictional Local Hazard Mitigation Plan. The jurisdictions that elected to participate in this plan are listed above in section 1.2. The Disaster Mitigation Act requires that each jurisdiction participate in the planning process and officially adopt the multi-jurisdictional hazard mitigation plan. Each jurisdiction that chose to participate in the planning process and development of the plan was required to meet plan participation requirements defined at the beginning of the process, which included the following:

- Designate a representative to serve on the HMPC
- Participate in at least one of three HMPC meetings by either direct representation or authorized representation
- Provide information to support the plan development by completing and returning the AMEC Data Collection Workbook
- Identify mitigation actions for the plan (at least one)
- Review and comment on plan drafts
- Inform the public, local officials, and other interested parties about the planning process and provide an opportunity for them to comment on the plan
- Formally adopt the mitigation plan

All three of the jurisdictions listed as official participants in this plan met all of these participation requirements.

Table 1.1 shows the representation of each participating jurisdiction at the planning meetings; sign-in sheets are included in Appendix B: Planning Process Documentation.

Table 1.1. Jurisdictional Participation in Planning Process

Jurisdiction	HMPC Kick-off Meeting	HMPC Meeting #2	HMPC Meeting #3	Data Collection Guide	Action(s)
Knox County	X	X	X	X	X
Town of Farragut	X	X		X	X

City of Knoxville	X	X	X	X	X

1.4.2 The Planning Process

AMEC and Knox County worked together to establish the framework and process for this planning effort using FEMA's *Local Multi-Hazard Mitigation Planning Guidance* (2008) and the State and Local Mitigation Planning How-To Guides (2001), which include *Multi-Jurisdictional Mitigation Planning* (2006). The plan is structured around a four-phase process:

1) Organize resources
2) Assess risks
3) Develop the mitigation plan
4) Implement the plan and monitor progress

Into this process, AMEC integrated a modified detailed 10-step planning process used for FEMA's Community Rating System (CRS) and Flood Mitigation Assistance programs. Thus, the modified 10-step process used for this plan meets the funding eligibility requirements of the Hazard Mitigation Grant Program, Pre-Disaster Mitigation program, Community Rating System, and Flood Mitigation Assistance program. Table 1.2 shows how the modified 10-step process fits into FEMA's four-phase process.

Table 1.2. Mitigation Planning Process Used to Develop the Knox County Multijurisdictional Local Hazard Mitigation Plan

DMA Process	Modified CRS Process
1) Organize Resources	
201.6(c)(1)	1) Organize the Planning Team
201.6(b)(1)	2) Involve the Public
201.6(b)(2) and (3)	3) Coordinate with Other Departments and Agencies
2) Assess Risks	
201.6(c)(2)(i), (iii)	4) Identify the Hazards
201.6(c)(2)(ii), (iii)	5) Estimate Losses
3) Develop the Mitigation Plan	
201.6(c)(3)(i)	6) Identify Goals and Objectives
201.6(c)(3)(ii)	7) Develop Potential Mitigation Actions
201.6(c)(3)(iii)	8) Draft the Action Plan
4) Implement the Plan and Monitor Progress	
201.6(c)(5)	9) Adopt the Plan

201.6(c)(4)	10) Implement, Evaluate, and Revise the Plan

Phase I Organize Resources

Step 1: Organize the Planning Team

The planning process resulting in the preparation of this plan document officially began with a kickoff meeting in Knoxville, Tennessee on March 30, 2011. Knox County mailed letters of invitation to jurisdictions in the county as well as state, local and regional organizations involved in mitigation planning.

A Hazard Mitigation Planning Committee (HMPC) was created that includes representatives from each participating jurisdiction, departments of the County , and other local and state organizations responsible for making decisions in the plan and agreeing upon the final contents. Kickoff meeting attendees discussed additional potential participants and made decisions about additional stakeholders to invite to participate on the HMPC. The agencies and organizations that participated in the planning meetings included the following:

Knox County Sheriff's Department
Knox County Air Quality
Knox County Code Administration
Knox County Development Corporation
Knox County Engineering/Stormwater Department
Knox County First Utility District
Knox County GIS Department
Knox County Health Department
Knox County Parks and Recreation Department
Knox County Property Assessor
Knox County Public Library
Knox County Rural/Metro Fire Department
Knox County Stormwater
Knox Emergency Management Agency
City of Knoxville
Knoxville Fire Department
Town of Farragut
Rural/Metro - Town of Farragut
Knoxville-Knox County Metropolitan Planning Commission
Rural Metro
Rural/Metro Emergency Medical Services
Tennessee Department of Environment and Conservation-Geology

A complete list of all representatives of the agencies and organizations that participated on the Knox County HMPC is provided in Appendix B.

The HMPC contributed to this planning process by:

- providing facilities for meetings,
- attending and participating in meetings,
- collecting data,
- managing administrative details,
- making decisions on plan process and content,
- submitting mitigation action implementation worksheets,
- reviewing drafts, and
- coordinating and assisting with public involvement and plan adoptions.

The HMPC communicated during the planning process with a combination of face-to-face meetings, phone interviews, and email correspondence. The meeting schedule and topics are listed in Table 1.3. The meeting minutes for each of the meetings are included in Appendix B.

Table 1.3. Schedule of HMPC Meetings

Meeting	Topic	Date
HMPC #1	Kickoff meeting: introduction to DMA, the planning process, hazard identification and public input strategy. Distribution of data collection guide to jurisdictions. Preliminary hazard ranking results.	March 30, 2011
HMPC #2	Review of draft Risk Assessment, Development of plan goals., handed out public questionnaire	May 26, 2011
HMPC #3	Mitigation action identification and prioritization. Determine process to monitor, evaluate, and update plan.	July 11, 2011

During the kickoff meeting, AMEC presented information on the scope and purpose of the plan, participation requirements of HMPC members, and the proposed project work plan and schedule. Plans for public involvement (Step 2) and coordination with other agencies and departments (Step 3) were discussed. AMEC also introduced hazard identification requirements and data needs. The HMPC discussed potential hazards as well as past events and impacts and future probability for each of the hazards. The HMPC refined the list of hazards to make it relevant to Knox County.

Participants were given the AMEC Data Collection Workbook to facilitate the collection of information needed to support the plan, such as data on historic hazard events, values at risk, and current capabilities. Each participating jurisdiction completed and returned the worksheets in the Data Collection Workbook document to AMEC. AMEC integrated this information into the plan, supporting the development of Chapters 2 and 3.

Figure 1.1 Hazard Mitigation Planning Committee Meeting #2

Step 2: Plan for Public Involvement

44 CFR Requirement 201.6(b): An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.

At the kickoff meeting, the HMPC discussed options for soliciting public input on the mitigation plan. The committee determined that the most effective way to inform the public about the planning effort underway and achieve their input would be dissemination of a survey.

During the drafting stage a survey was developed specific to the Knox County Mitigation Plan. This survey provided a brief plan summary as well as a questionnaire to capture public and stakeholder input. Each committee member distributed a public survey to members of the public and key stakeholders in their own jurisdiction. In addition, the

survey was made available on the county website at www.knoxcounty.org/stormwater and in hard copy at the following locations from May 26, 2011 through June 10, 2011:

- Knox County - Stormwater Department
- City of Knoxville - Stormwater Management Department of Engineering
- Farragut Town Hall

The survey, provided in Appendix B, asked the public and stakeholders to indicate the level of risk significance in Knox County that they perceive for each hazard. They were asked to rate the impacts of each hazard profiled in this plan as 1=low significance, 2=moderate significance, or 3=high significance. Six surveys were completed resulting in the ranking order provided in Table 1.4 from greatest perceived risks to least perceived risk. To provide a comparison, the magnitude level determined by the Hazard Mitigation Planning Committee is provided in the far right column. Additional elements were considered by the committee to determine the overall planning significance. The complete hazard ranking methodology used by the committee as well as the results is discussed in detail in Chapter 3.

Table 1.4 Public Perception of Hazard Impacts (High to Low)

Public Hazard Ranking	HMPC Hazard Ranking
Flood	Severe Storms
Severe Storms	Extreme Temperatures
Tornado	Flood
Land Subsidence and Sinkholes	Land subsidence & sinkholes
Dam Failure	Winter Storms
Drought	Landslides
Landslides	Wildfires
Earthquake	Earthquake
Expansive Soils	Tornado
Extreme Temperatures	Drought
Winter Storms	Dam Failure
Wildfires	Expansive soils

In the survey, the public was also asked to review six categories of actions being considered in the Knox County Multi-Jurisdictional Local Hazard Mitigation Plan. The survey asked the public to place a check next to the four categories of mitigation actions

that they felt should receive the highest priority in the plan's mitigation strategy. Table 1.5 provides the compiled results of this question.

Table 1.5 Public Prioritization of Mitigation Categories

Project Type	Total Public
Prevention	6
Structural Projects	5
Emergency Services	5
Natural Resource Protection	4
Property Protection	2
Public Education and Awareness	1

Other specific issues that the public noted for the planning committee to consider are provided below:

"Safety of bridges, including rail bridges"

"I'm all about education".

The public was also given an opportunity to provide input on a draft of the complete plan prior to its submittal to the State and FEMA.

The jurisdictions announced the availability of the draft plan and the public comment period in the Knoxville News Sentential. This newspaper has circulation throughout the County. A copy of the press release is provided in Appendix B.

The HMPC invited other targeted stakeholders to comment on the draft plan via an e-mail letter, which is described in greater detail in Step 3: Coordinate with Other Departments and Agencies. Minor comments were received and incorporated.

Step 3: Coordinate with Other Departments and Agencies

44 CFR Requirement 201.6(b): An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (2) 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 private and non-profit interests to be involved in the planning process. (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

There are numerous organizations whose goals and interests interface with hazard mitigation in Knox County. Coordination with these organizations and other community planning efforts is vital to the success of this plan. Knox County invited other local, state, and federal departments and agencies to the kickoff meeting to learn about the hazard mitigation planning initiative. In addition, the HMPC developed a list of neighboring communities and local and regional agencies involved in hazard mitigation activities, as well as other interests, to invite by letter to review and comment on the draft of the Knox County Multijurisdictional Local Hazard Mitigation Plan prior to submittal to the state and FEMA. These include emergency management officials of adjacent counties, members of academic organizations, and state and federal agencies. A copy of the e-mail letter that was sent and the address list is provided in Appendix B. Due to the large planning area included in this effort and the vast number of other potential stakeholders in the business community, private non-profit organizations, and the general public, the news article and surveys distributed by each jurisdiction were utilized to ensure notification, inclusion, and opportunity for involvement from these sectors.

As part of the coordination with other agencies, the HMPC collected and reviewed existing technical data, reports, and plans. These included the 2010 Tennessee State Hazard Mitigation Plan, reports from the National Flood Insurance Program's Community Information System, information from the National Inventory of Dams, the Knox County Flood Insurance Study, the 2010 Tennessee Drought Management Plan, the Draft Hillside and Ridgetop Protection Plan, the 1995 Investigation of Sinkhole Flooding Problems in Knoxville, Tennessee, the Knox County Tennessee Stormwater Management Manual, and the 2008 University of Tennessee, Knoxville Multi-Hazard Mitigation Disaster Resistant University Plan as well as other data from state and federal agencies. This information was used in the development of the hazard identification, vulnerability assessment, and capability assessment and in the formation of goals, objectives, and mitigation actions. These sources are documented throughout the plan and in Appendix A, References.

Phase 2 Assess Risk

Step 4: Identify the Hazards

AMEC assisted the HMPC in a process to identify the natural hazards that have impacted or could impact communities in Knox County. At the kickoff meeting, the HMPC examined the history of disaster declarations in Knox County, the list of hazards

suggested by FEMA for consideration, and additional hazards included in the Tennessee State Hazard Mitigation Plan. The committee then worked through this list of all potential hazards that could affect the planning area. They discussed past hazard events, types of damage, and where additional information might be found. There were several hazards that the committee chose to exclude from further review. Justification is provided for each hazard removed from further review in Section 3.1.

During the kick-off meeting, the HMPC refined the list of hazards to make the analysis relevant to Knox County, discussed past events and impacts and came to consensus on the probability, and magnitude for each hazard. Prior to the meeting, a profile of each of these hazards had been developed. Web resources, existing reports and plans, and existing geographic information systems (GIS) layers were used to compile information about past hazard events. After this meeting, the preliminary research and supplementary information and results of discussion by the HMPC, was compiled to develop complete hazard profiles detailing the location, previous occurrences, probability of future occurrences, and magnitude/severity of each hazard. The data collection workbook distributed at the kickoff meeting was returned to AMEC by each participating jurisdiction and also provided supplemental jurisdictional-specific information to identify hazards and vulnerabilities. More information on the methodology and resources used to identify and profile the hazards can be found in Sections 3.1 and 3.2.

Step 5: Estimate Losses

After profiling the hazards that could affect Knox County, the HMPC collected information to describe the likely impacts of future hazard events on the participating jurisdictions.

Vulnerability Assessment - Participating jurisdictions inventoried their assets at risk to natural hazards—overall and in identified hazard areas. These assets included total number and value of structures; critical facilities and infrastructure; natural, historic, and cultural assets; economic assets; and vulnerable populations. The HMPC also considered development trends in known hazard areas. FEMA's loss estimation computer software, HAZUS-MH, was utilized to provide information on populations at risk as well as estimated numbers and values of buildings at risk. The assets at risk were discussed for the planning area as a whole for those hazards that do not vary geographically. Additionally, utilizing the HAZUS-MH tool, assets at risk to a 100-year

flood in Knox County were discussed separately as this hazard varies across the planning area**.**

Capability Assessment - This assessment consisted of identifying the existing mitigation capabilities of participating jurisdictions. This involved collecting information about existing government programs, policies, regulations, ordinances, and plans that mitigate or could be used to mitigate risk from hazards. Participating jurisdictions collected information on their regulatory, personnel, fiscal, and technical capabilities, as well as previous and ongoing mitigation initiatives. This information is included in Chapter 2 Planning Area Profile and Capabilities.

Taking into consideration the vulnerability and capability assessments, and where sufficient information was available, a variety of methods was used to estimate losses for each profiled hazard. For the dam failure, flood, and earthquake hazards, FEMA's loss estimation computer software, HAZUS-MH was utilized to estimate losses in the planning area. The methodologies for each lost estimate are described in detail Section 3.3.3, where applicable.

Results of the preliminary risk assessment were presented and comments discussed during the kick-off meeting. AMEC provided the draft risk assessment to the HMPC at the second meeting on May 26, 2011 for review and comment by the committee. Several comments, corrections, and suggestions were provided to AMEC and incorporated into the risk assessment as appropriate.

Phase 3 Develop the Mitigation Plan

Step 6: Set Goals

AMEC facilitated a brainstorming and discussion session with the HMPC during their second meeting to identify goals for the overall multi-jurisdictional local hazard mitigation plan. To focus the committee on the issues brought out by the risk assessment, key issues were summarized for each hazard profiled. Then the HMPC discussed the definition and purpose of goal statements and reviewed examples of goals from the State Mitigation Plan and other local plans. Then, as a group, through a group voting exercise, the HMPC achieved consensus on the final goals for the multi-jurisdictional local hazard mitigation plan, which are described in Chapter 4.

Step 7: Review Possible Activities

At the final meeting the HMPC reviewed the Tennessee Emergency Management Agency's HMA funding priorities as well as a handout describing the types of mitigation projects generally recognized by FEMA. The group discussed the types of mitigation actions/projects that could be done by the jurisdictions in Knox County. Consideration was given to the identified key issues that were developed from the risk assessment and the anticipated success for each project type. Committee members discussed issues such as availability of funds, actions that should receive priority, feasibility of actual implementation utilizing the STAPLEE methodology as a guide. Projects such as emergency preparedness drills were discussed, but were given low priority because the response-related mitigation actions occur on a routine basis as requirements of other plans. Complex projects that would necessitate use of large numbers of county resources were also discussed. This opportunity to discuss a broad range of mitigation alternatives allowed the jurisdictions wishing to complete projects to understand the overall priorities of the committee and to allow for discussion of the types of project most beneficial to each jurisdiction. Projects were discussed within the context of the priorities and likelihood of success/failure for each was determined. As part of this discussion, consideration was given to the potential cost of each project in relation to the anticipated future cost savings. Following the project/action discussion, action forms were distributed to all committee members along with a modified form of the STAPLEE process to evaluate each action. These completed worksheets were returned to AMEC. Each participating jurisdiction prioritized the projects they submitted by indicating high, moderate, or low local priority.

Step 8: Draft the Plan

A complete draft of the plan was made available online and in hard copy for review and comment by the public and other agencies and interested stakeholders. This review period was from October 3rd through October 7th, 2011 and a public meeting was held on October 5th, 2011. Methods for inviting interested parties and the public to review and comment on the plan were discussed in Steps 2 and 3, and materials are provided in Appendix B. Comments were integrated into a final draft for submittal to the Tennessee Emergency Management Agency and FEMA Region IV.

Phase 4 Implement the Plan and Monitor Progress

Step9: Adopt the Plan

To secure buy-in and officially implement the plan, the governing bodies of each participating jurisdiction adopted the plan. Scanned copies of resolutions of adoption are included in Appendix D of this plan.

Step 10: Implement, Evaluate, and Revise the Plan

The HMPC developed and agreed upon an overall strategy for plan implementation and for monitoring and maintaining the plan over time during Meeting #3. This strategy is described in Chapter 5 Plan Maintenance Process.

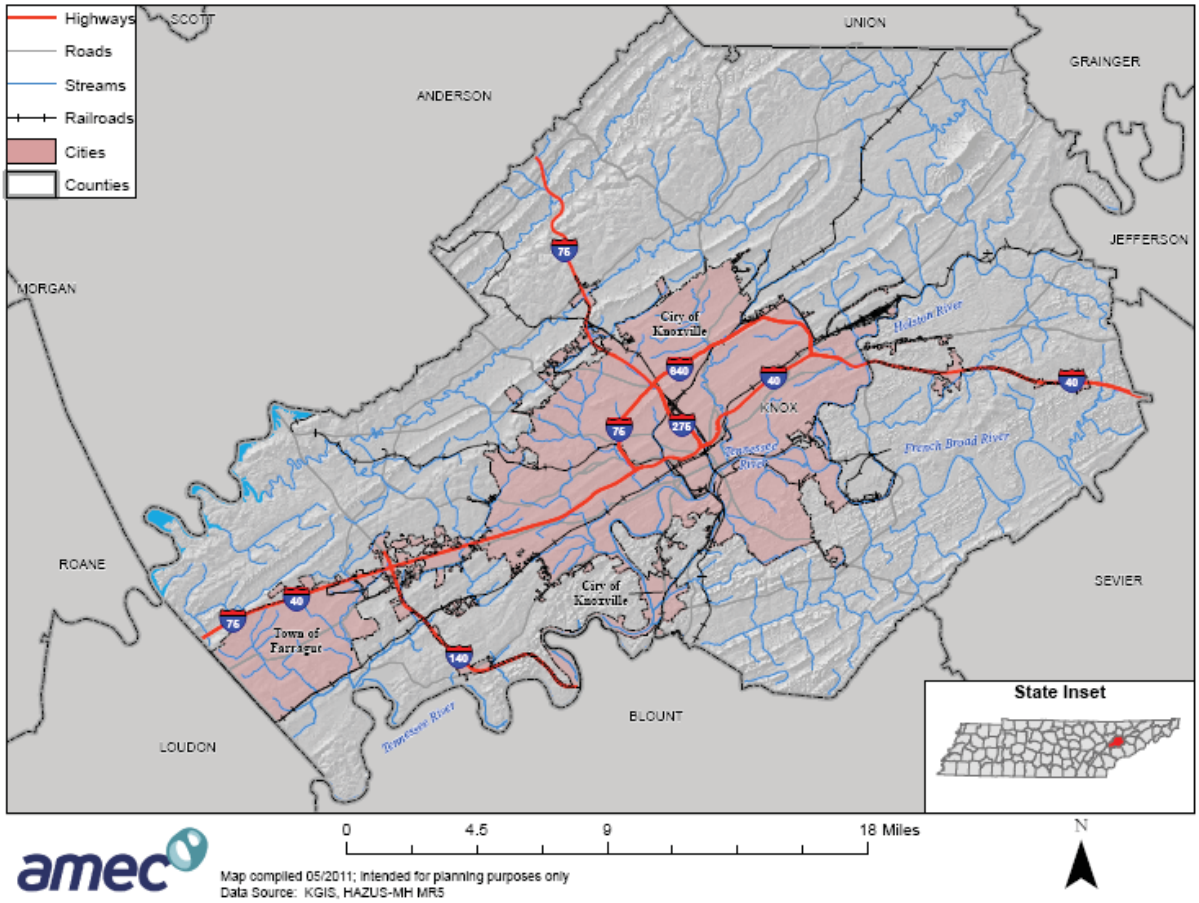
2 PLANNING AREA PROFILE AND CAPABILITIES

Chapter 2 provides a general profile of Knox County followed by descriptions of each of the jurisdictions participating in this plan and their existing mitigation capabilities.

2.1 Knox County Planning Area Profile

Figure 2.1 provides a map of the Knox County planning area.

Figure 2.1 Knox County Planning Area



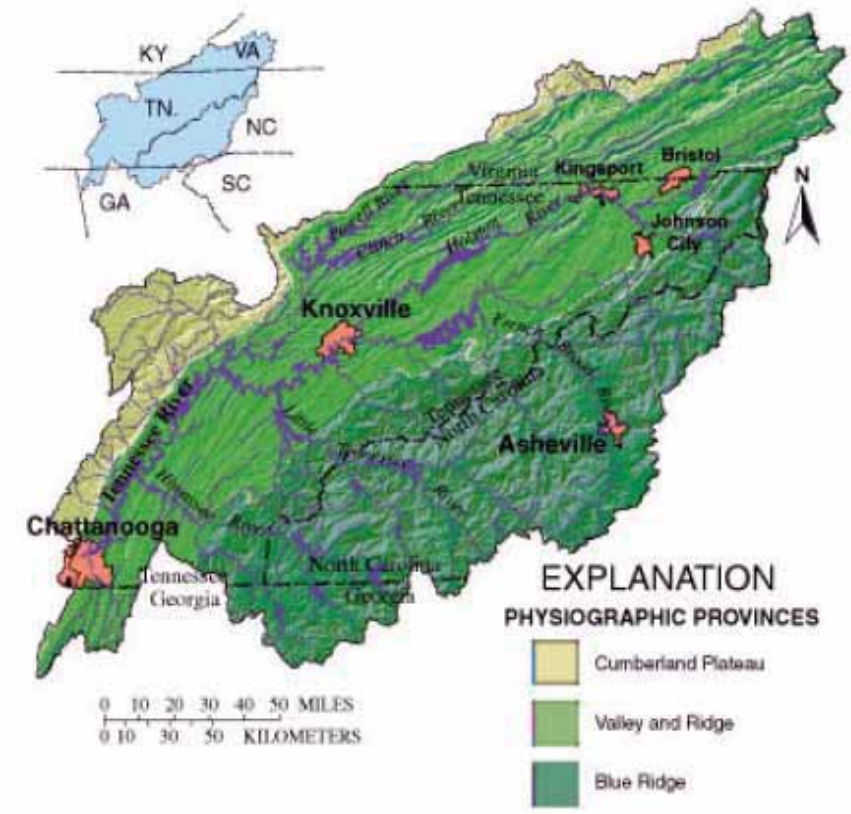
2.1.1 Geography and Topography

Knox County is located in north central Tennessee, slightly west of the center of the state. Knox County is bounded by eight neighboring counties; on the north by Anderson and Union Counties, on the east by Grainger, Jefferson, and Sevier Counties, on the

south by Blount and Loudon Counties, and on the west by Roane County. The County Seat is the City of Knoxville, also the largest city in the County. The land area of Knox County is 526 square miles.

As shown in Figure 2.2, the County is in the valley and ridge physiographic region. The region comes down from north-east Tennessee and Virginia and a band extends southwest with the Tennessee River through Chattanooga, Tennessee.

Figure 2.2 Upper Tennessee River Basin



Source: USGS Circular 1205 http://pubs.usgs.gov/circ/circ1205/introduction.htm

The State of Tennessee is divided into 10 major drainage basins. Knox County is located within the Upper Tennessee River Basin as seen in Figure 2.2. The Upper Tennessee River Basin encompasses about 21,390 square miles and flows through portions of Virginia, North Carolina, Tennessee, and Georgia. It has three physiographic provinces-the Cumberland Plateau, Valley and Ridge, and Blue Ridge.

In 1995, withdrawals of surface and ground water in the Upper Tennessee River Basin totaled about 4.8 billion gallons per day. Surface-water withdrawals for cooling at thermoelectric plants accounted for about 3.5 billion gallons per day, or 73 percent of this total. Other uses were commercial and industrial, 702 million gallons per day; public

and domestic supply, 394 million gallons per day; agricultural, 203.3 million gallons per day: and mining, 10.4 million gallons per day, all of which were predominantly surface-water withdrawals. A total of 897 facilities were permitted to discharge wastewater in 1995 to area streams.

Total ground-water withdrawals in the basin for 1995 were about 138 million gallons per day and accounted for about 10.5 percent of the total non-thermoelectric water use in the basin. About 77 percent of the ground-water withdrawals were for public and domestic supply for over one-third of the basin's population.

2.1.2 Climate

Knox County is in a temperate climate zone. The summers are usually green and gentle. The fall has lots of color from trees, and winter is usually brief and mild. Spring arrives early and stays a long time.

Precipitation totals for the months of December through February are generally the lowest of the year. Additional specific climate information was obtained for the Knoxville, Tennessee and is provided in Table 2.1 below and is fairly representative of the planning area. According to this climate information the planning area averages about 204 sunny days per year and annual snowfall is 19 inches less than the national average. The comfort index for Knox County is 38 out of 100 where higher is more comfortable. This index is based on humidity during the hot months. The U.S. average comfort index is 44.

Table 2.1 Knox County, Tennessee Annual Climate Averages

Climate	Knox County	United States
Annual Rainfall (inches)	47.4	36.5
Annual Snowfall (inches)	6	25
Precipitation Days (annual total)	119	100
Sunny Days (annual total)	204	205
Average July High Temperature (°F)	88	86.5
Average January Low Temperature (°F)	30.3	20.5

Source: Sperling's Best Places, http://www.bestplaces.net/city/tennessee/knoxville#

2.1.3 Population/Demographics

According to the U.S. Census, the 2010 population for Knox County was 432,226. Population density is 822 people per square mile (526 total square miles in the County). County population increased 11.6 percent from 2000 to 2010. Population and housing unit changes for the planning area are provided in Table 2.2.

Table 2.2 Change in Population and Housing Units, 2000-2010

Location	2000 Population	2010 Population	Percent Change 2000-2010	2000 Housing Units	2010 Housing Units	Percent Change 2000 - 2010
Knox County	382,032	432,226	11.6	171,439	194,949	12.0
City of Knoxville	173,890	178,874	2.8	84,981	88,009	3.4
Town of Farragut	17,718	20,676	14.3	6,627	7,982	17.0

Source: U.S. Census Bureau

Selected U.S. Census 2005-2009 demographic and social characteristics for Knox County are shown in Table 2.3. Characteristics for Knox County are for the entire planning area.

Table 2.3 Knox County Demographic and Social Characteristics

Jurisdiction	Under 5 Years (%)	65 Years and Over (%)	Average Household Size	High School Graduates (%)	Bachelor Degree or Higher (%)	Individuals Below Poverty (%)
U.S.	6.9	12.9	2.6	84.6	27.5	13.5
Tennessee	6.7	12.6	2.49	81.8	22.4	16.1
Knox County	6.2	12.8	2.32	87.7	33.0	14.7
City of Knoxville	6.1	13.1	2.07	83.8	28.3	25.0
Town of Farragut	6.0	14	2.73	97.5	56.5	2.7

Source: 2005-2009 American Community Survey 5-Year Estimates, U.S. Census Bureau, http://factfinder.census.gov;

2.1.4 History

Founded in 1791 where the French Broad and Holston Rivers meet to form the Tennessee River, Knoxville is the largest city in East Tennessee, ranking third largest in the State. It is located in a broad valley between the Cumberland Mountains to the northwest and the Great Smoky Mountains to the southeast. These two ranges afford an attractive natural setting and provide a moderate, four-season climate, with average monthly temperatures ranging from 30 degrees in January to 88 degrees in July. The City of Knoxville comprises 104± square miles of the 526-square mile total for Knox County. Downtown Knoxville is 936 feet above sea level.

2.1.5 Economy/Industry

According to the Tennessee Department of Labor and Workforce Development, the April 2010 industries that employed the highest percentage of Knox County's labor force

(full and part-time, non-farm wage and salary employees, and self-employed persons) were, in percentage order; government, educational and health services, professional business services, retail trade, and leisure and hospitality.

The civilian labor force in the Knoxville Metropolitan Statistical Area (MSA) was 375,210 in April 2011. According to the Tennessee Department of Labor & Workforce Development, April 2011, unemployment rate was 7.7 percent for Knox County which was the state's lowest metropolitan area rate. The statewide unemployment rate was 9.6 percent for that same period.

Table 2.4 lists selected economic characteristics for Knox County, the City of Knoxville, and the Town of Farragut from the Tennessee Department of Labor & Workforce Development.

Table 2.4 Knox County Economic Characteristics by Jurisdiction, 2005-2009

Jurisdiction	Median Household Income ($)	Median Home Value ($)	Median Monthly Mortgage ($)	Population 16+ in Labor Force (%)	Top Three Employing Industries
U.S.	$51,425	$185,400	$1,486	153,407,584	Educational services, healthcare & social assistance, retail trade, & manufacturing
Tennessee	$42,943	$128,500	$1,136	3,068,198	Educational services, healthcare & social assistance, manufacturing, & retail trade
Knox County	$46,233	$147,200	$1,193	341,226	Educational services, healthcare & social assistance, retail trade, & professional, scientific, & management services
City of Knoxville	$32,609	$109,600	$1,038	93,461	Educational services, healthcare & social assistance, retail trade,& arts, entertainment, and recreation
Town of Farragut	$95,106	$293,900	$1,837	9,703	Educational services, healthcare & social assistance, & professional, scientific, & management services, & retail trade

Source: 2005-2009 American Community Survey 5-Year Estimates, U.S. Census Bureau, http://factfinder.census.gov;

2.1.6 Agriculture

Agriculture is a declining component of the economy in Knox County. In 2002, there were 1,410 farms in the County with 93,563 acres, while in 2007 there is a 13 percent decline with only 1,224 farms and 82,938 acres.

In 2007, overall value of crops harvested was $11,971,000 and the value of livestock sales was $7,408,000. Table 2.5 below shows the production quantity and the state rank for the main agricultural products in Knox County.

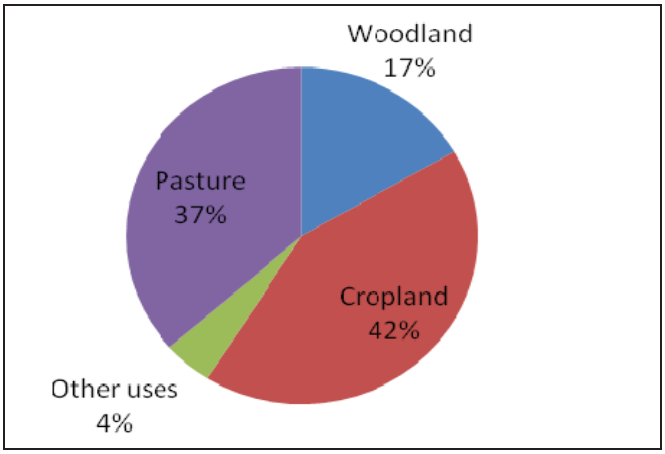
Table 2.5 Knox County Agricultural Commodity Groups, 2007

Commodity	Quantity ($)	State Rank
Grains, oilseeds, dry beans, & dry peas	57,000	84
Tobacco	50,000	45
Vegetables, melons, potatoes, & sweet potatoes	91,000	38
Fruits, tree nuts, & berries	20,000	28
Nursery, greenhouse, floriculture, & sod	11,265,000	2
Cut Christmas trees and short rotation woody crops	38,000	11
Other crops and hay	450,000	22
Poultry and eggs	24,000	58
Cattle and calves	4,730,000	53
Milk and other dairy products from cows	1,532,000	33
Hogs and pigs	41,000	40
Sheep, goats, and their products	100,000	23
Horses, ponies, mules, burros, and donkeys	888,000	8
Other animals and other animal products	92,000	9

Source: U.S. Department of Agriculture, 2007 census of agriculture, Knox County, TN Profile.

As noted in Figure 2.3 below, cropland and pasture land make up the largest percentages of the farmland in Knox County.

Figure 2.3 Land in Farms by Type of Land in Knox County, TN.



Source: U.S. Department of Agriculture, 2007 census of agriculture, Knox County, TN Profile.

2.2 Jurisdictional Descriptions and Capabilities

The mitigation capabilities for each of the jurisdictions participating in the plan are profiled in the section that follows. These profiles include an overview of the jurisdiction and its organizational structure; a description of staff, fiscal, and technical resources; and information regarding existing hazard mitigation capabilities such as adopted plans policies and regulations, if any. The descriptions and capabilities assessments are based on available and applicable data, including information provided by the jurisdictions collected during the planning process.

In the subsections that follow, Sections 2.2.1 and 2.2.2 summarize mitigation capabilities for Knox County, the City of Knoxville and Town of Farragut respectively.

2.2.1 Knox County

Overview

The jurisdiction of Knox County includes all unincorporated areas within the County boundaries. Knox County has an eleven-member elected commission as well as the following elected officers of: Mayor, County Clerk, Courts, Law Director, Property Assessor, Register of Deeds, Sheriff, and Trustee. The Knox County government includes the following departments:

Air Quality
Codes
Community Outreach
Communications
Community Development
Election Commission
Engineering
Ethics Committee
Finance
Fire Prevention Bureau
Health Department
Human Resources
Information Technology
KGIS
Parks & Recreation
Public Library
Retirement
Senior Services
Solid Waste & Recycling
Stormwater Management
Veteran's Services

Technical and Fiscal Resources

Knoxville-Knox County has a joint city-county office for emergency management services. 0 outlines Knox County personnel resources in 2011.

Table 2.6 Knox County Administrative and Technical Resources

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	YES	Knoxville-Knox County Metropolitan Planning Commission
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	YES	Engineering& Public Works Dept.
Planner/Engineer/Scientist with an understanding of natural hazards	YES	Knoxville-Knox County Metropolitan Planning Commission
Personnel skilled in GIS	YES	KGIS & Knoxville-Knox County Metropolitan Planning Commission
Full time building official	YES	Codes Dept.
Floodplain Manager	YES	Engineering & Public Works Dept., Stormwater Engineering Division
Emergency Manager	YES	Emergency Mgmt Dept
Grant writer	YES	Community Development

Source: Knox County's Data Collection Workbook completed 2011.

Fiscal tools or resources that the County could potentially use to help fund mitigation activities include the following:

- Community Development Block Grants
- Capital improvements project funding
- Authority to levy taxes for specific purposes
- Incur debt through general obligation bonds
- Incur debt through special tax bonds
- Incur debt through private activities
- Withhold spending in hazard prone areas

Existing Plans and Policies

The County joined the regular phase of the National Flood Insurance Program on July 23, 1971 and also participant in the Community Rating System as a Class 9. They maintain elevation certificates on properties in the floodplain.

Table 2.7 Knox County Regulatory Tools

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
General Plan	YES	
Zoning ordinance	YES	
Subdivision ordinance	YES	
Growth management ordinance	YES	
Floodplain ordinance	YES	
Other special purpose ordinance (stormwater, steep slope, wildfire)	YES	
Building code	YES	
BCEGS Rating	YES	3-Commercial and 4-Residential
Fire department ISO rating	YES	Ratings:4-6 (varies across county)
Erosion or sediment control program	YES	
Stormwater management program	YES	
Site plan review requirements	YES	
Capital improvements plan	YES	
Economic development plan	YES	
Local emergency operations plan	YES	Part of Knox County EMA Plan
Other special plans (i.e. flood mitigation plan)		
Flood insurance study or other engineering study for streams	YES	
Elevation certificates	YES	

Other Mitigation Activities

Knox County has several mitigation type programs already established. The following are highlights from some of the departments:

Emergency Management Agency

- Knoxville-Knox County Emergency Management Agency has prepared a disaster preparedness manual for the citizens called, It's a Disaster Knoxville and What are You Gonna Do About It?
- Citizen Preparedness Information. Knoxville-Knox County Emergency Management Agency is the administrator for the Knoxville LEPC (Local Emergency Planning Committee) and hosts the website http://knoxtnlepc.com. The site includes information on Metropolitan Medical Response System

(MMRS), Community Emergency Response Team (CERT), Knoxville Animal Response Team (KDART), and Get Ready Knoxville Preparedness program.
- Provide training to emergency responders and public organizations on topics such as terrorism, weapons of mass destruction, assisting children in disasters, structural collapse, incident command, weather spotter, and CERT (Community Emergency Response Team) Training and Team.

Fire Prevention Bureau

- Promotes numerous public fire education programs such as Life Safety House, Fire Trucks/Fire Station visits, E.D.I.T.H. (Exit Drills in the Home), Fireknowledge101.com, fire safety tips on their website, public events, smoke detector programs, and juvenile firesetter intervention program.

Stormwater

- Rainy Day Brushoff (water conservation and environmental education)
- Tennessee Yards and Neighborhoods (conservation and education)
- Environmental Stewardship Program (conservation and education)
- Adopt-A-Watershed (conservation and education)
- Adopt-A-Stream (education)
- Contractor Education Program (education)

Air Quality

- Issues open burning permit to residents when weather conditions allow thus trying to mitigate fires getting out of control.

Health Department

- Emergency/Bioterrorism Preparedness Department is to ensure Public Health preparedness and establish an effective response to bioterrorism, infectious disease outbreaks, emergencies and other public health threats.
- Provides education and training to key health personnel who respond to public health emergencies. Coordinates the education and training with other health and emergency agencies. Provides training to community members who volunteer to work in Mass Dispensing/Vaccination Clinics. Organizes and participates in emergency drills.

2.2.2 City of Knoxville and Town of Farragut

The City of Knoxville and the Town of Farragut participated in the planning development process. The amount of information regarding mitigation capabilities of these participating jurisdictions varies, but each support the mitigation goals of the planning area overall. Descriptions of each are provided below as reported in their completed data collection workbooks and Table 2.12 at the end of this section summarizes the mitigation related capabilities of these jurisdictions.

City of Knoxville

Overview

The City of Knoxville is located near the center of the Great Valley of East Tennessee at the headwaters of the Tennessee River.

The 2010 population for Knoxville was 178,874. The City is governed by a Mayor and a nine member City Council. There is also over thirty boards, commissions and committees that allow for public input and participation for the different City agencies and services. Those City services are currently staffed and managed by the following 41 offices and departments:

Building Inspections Division
Business License/Tax Office
City Council's Office
City Court
Civic Coliseum and Auditorium
Civil Service
Codes Enforcement Section
Community Development Division
Community & Neighborhood Services
Community Relations
Engineering
Finance & Accountability Dept.
Fire Dept.
Fire Codes & Inspections
Fleet Services Division
Household Garbage Collection
Information Services Division
KAT
KEMA
KCDC
Knoxville Utilities Board
Law Department
Mayor's Office
McGee Tyson Airport
Metropolitan Planning Commission
Parks and Recreation
Police Dept.
Policy & Communications
Property Tax Office
Public Services Division
Purchases Division
Recreation Centers
Recycling
Solid Waste
South Waterfront Development
Special Events
Stormwater
Street Repair, Potholes, Brush & Leaf Pickup
Traffic
Water Quality Hotline
World's Fair Park Zoo

Technical and Fiscal Resources

The City of Knoxville has staff resources in planning, engineering, and floodplain management. Knoxville-Knox County has a joint city-county office for emergency management services. There is a Knox County Emergency Communications District that handles all 911 calls. 0 outlines the City's personnel resources in 2011.

Table 2.8 Knoxville's Administrative and Technical Resources

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	YES	Knoxville-Knox County Metropolitan Planning Commission
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	YES	Engineering
Planner/Engineer/Scientist with an understanding of natural hazards	YES	Knoxville-Knox County Metropolitan Planning Commission
Personnel skilled in GIS	YES	Knoxville-Knox County Metropolitan Planning Commission and KGIS
Full time building official	YES	Public Works Dept., Plans Review & Inspections Division
Floodplain Manager	YES	Engineering Dept., Stormwater Engineering Division
Emergency Manager	YES	Emergency Mgmt Dept
Grant writer	YES	Community Development

Source: Knoxville's Data Collection Workbook completed 2011.

Fiscal tools or resources that the City could potentially use to help fund mitigation activities include the following:

- Community Development Block Grants
- Capital improvements project funding
- Authority to levee taxes for specific purposes
- Fees for water, sewer, gas or electric services
- Incur debt through general obligation bonds
- Incur debt through special tax bonds

Existing Plans and Policies

Knoxville has adopted a master plan, zoning ordinance, and subdivision ordinance that are available to the public on the internet. The building code that the Knoxville adheres to is the 2012 International Building Code. The Emergency Operations Plan is administered by the Knoxville-Knox County Emergency Management Agency.

The City joined the regular phase of the National Flood Insurance Program on April 30, 1971 and also participant in the Community Rating System as a Class 8 community. They maintain elevation certificates on properties in the floodplain. Table 2.9 below details regulatory tools for the City of Knoxville.

Table 2.9 City of Knoxville Regulatory Tools

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
General Plan	YES	
Zoning ordinance	YES	
Subdivision ordinance	YES	
Growth management ordinance	NO	Growth policy plan but no ordinance
Floodplain ordinance	YES	
Other special purpose ordinance (stormwater, steep slope, wildfire)	YES	
Building code	YES	BCEGS 4-Commercial and 4-Residential
Fire department ISO rating	3	
Erosion or sediment control program	YES	
Stormwater management program	YES	
Site plan review requirements	YES	
Capital improvements plan	YES	
Economic development plan	YES	
Local emergency operations plan	YES	Part of Knox County EMA Plan
Other special plans (i.e. flood mitigation plan)		
Flood insurance study or other engineering study for streams	YES	
Elevation certificates	YES	

Other Mitigation Activities

The City of Knoxville has several mitigation type programs already established. The following are highlights from some of the departments:

Emergency Management Agency:

- Knoxville-Knox County Emergency Management Agency has prepared a disaster preparedness manual for the citizens called, It's a Disaster Knoxville and What are You Gonna Do About It?
- Citizen Preparedness Information. Knoxville-Knox County Emergency Management Agency is the administrator for the Knoxville LEPC (Local Emergency Planning Committee) and hosts the website http://knoxtnlepc.com.

The site includes information on Metropolitan Medical Response System (MMRS), Community Emergency Response Team (CERT), Knoxville Animal Response Team (KDART), and Get Ready Knoxville Preparedness program.

- Provide training to emergency responders and public organizations on topics such as terrorism, weapons of mass destruction, assisting children in disasters, structural collapse, incident command, weather spotter, and CERT (Community Emergency Response Team) Training and Team.

Fire Department:

- Public Fire Education Division promotes Safety City where every 2nd-grade child learns traffic and personal safety from the Knoxville Police Department, numerous safety tips on various topics located on their website, and a smoke detector program where a smoke detector and batteries are provide free of charge to citizens in need.

Police Department

- Safety Education Unit Programs such as: Life Skills Training which is taught in the Knox County schools; Neighborhood Watch which encourages citizens to take ownership of their neighborhood; Boys & Girls Club Liaison Officer for officers to serve as mentors, Child Safety and several other prevention and safety programs.

Town of Farragut

Overview

The Town of Farragut encompasses 16.2 square miles and was incorporated on January 16, 1980. The Town is named after Admiral David Glasgow Farragut, the first Admiral of the United States Navy, who was born in the Farragut area.

Farragut is bound to the north by Interstate 40/75 except at Campbell Station Road, Snyder Road and the Outlets Drive area; to the south by Turkey Creek Road and the Norfolk Southern Railroad line; to the west at the Loudon County Line; and to the east by Lovell Road on the north side of Kingston Pike and Thornton Heights and Concord Hills subdivisions on the south side of Kingston Pike.
The 2010 population for Farragut was 20,676. The Town is governed by a mayor-aldermanic charter. The Board of Mayor and Aldermen, which consists of a mayor and four aldermen, serves as the government body. The Town services are currently staffed and managed by the following offices and departments:

- Administration
- Community Development
- Engineering

- Parks & Leisure Services
- Public Works

Technical and Fiscal Resources

The Town of Farragut has staff resources in planning, engineering, and floodplain management. Law enforcement for the Town is provided by the Knox county Sheriff's Department. There is a Knox County Emergency Communications District that handles all 911 calls. Table 2.10 outlines the City's personnel resources in 2011.

Table 2.10 Farragut's Administrative and Technical Resources

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	YES	Community Dev. Director
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	YES	Town Engineer
Planner/Engineer/Scientist with an understanding of natural hazards	YES	Town Engineer
Personnel skilled in GIS	YES	Consultant
Full time building official	YES	Senior Codes Inspector
Floodplain Manager	YES	Community Dev. Director
Emergency Manager	YES	Rural Metro/Town
Grant writer	YES	Town Engineer/Staff

Source: Farragut Data Collection Workbook completed 2011.

Fiscal tools or resources that the Town could potentially use to help fund mitigation activities include the following:

- Capital improvements project funding
- Authority to levy taxes for specific purposes
- Incur debt through general obligation bonds
- Incur debt through special tax bonds
- Withhold spending in hazard prone areas

Existing Plans and Policies

Farragut has adopted a master plan, zoning ordinance, and subdivision ordinance that are available to the public. The building code that Farragut adheres to is the 2006 International Building Code. The Emergency Operations Plan is administered by the Knoxville-Knox County Emergency Management Agency.

The Town joined the regular phase of the National Flood Insurance Program on July 23, 1971. They maintain elevation certificates on properties in the floodplain. Table 2.11 below details regulatory tools for the Town of Farragut.

Table 2.11 Farragut Regulatory Tools

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
General Plan	YES	Land Use and Transportation Plan
Zoning ordinance	YES	
Subdivision ordinance	YES	
Growth management ordinance	NO	
Floodplain ordinance	YES	
Other special purpose ordinance (stormwater, steep slope, wildfire)	YES	There is a sinkhole ordinance and a steep slope ordinance.
Building code	YES	2006 International Building Code
BCEGS Rating	3	
Fire department ISO rating	4	
Erosion or sediment control program	YES	
Stormwater management program	YES	
Site plan review requirements	YES	
Capital improvements plan	YES	
Economic development plan	YES	
Local emergency operations plan	YES	Part of Knox County EMA Plan
Other special plans (i.e. flood mitigation plan)	YES	Community Facilities & Services Plan
Flood insurance study or other engineering study for streams	YES	
Elevation certificates	YES	
Other		Parks & Leisure Services Master Plan, and Pedestrian & Bicycle Plan

Source: Farragut Data Collection Workbook completed 2011.

Other Mitigation Activities

The Town of Farragut has several mitigation projects already established. The following are highlights:

- Stormwater Matters. This is a Town program to encourage a watershed based partnership with the community & neighboring jurisdictions. The motto is, “if it isn’t stormwater, it shouldn’t be going into that storm drain, drainage ditch or stream”. It promotes citizens to make a difference with Adopt-A-Stream, Scoop the Poop, and Internships for Farragut High School students.
- Sediment Bedloading Study, Little Turkey Creek. The University of Tennessee's Department of Civil & Environmental Engineering in Partnership with the Town of Farragut will be conducting a Sediment Bedloading Study on Little Turkey Creek just off of the greenway at the Bridge at Old Stage Road. This process involves the installation of several concrete cells into the bed of the creek along with some monitoring equipment and an interpretive sign. This study is anticipated to last 3 years and the data collected will be useful in stream restoration efforts in East Tennessee.
- Campbell Station Park Stream Buffer Demonstration Project. The University of Tennessee Environmental Landscape Design Lab, in conjunction with the Town of Farragut, has been conducting a stream buffer demonstration project at since Fall 2007. This project includes invasive plant removal, planting of native riparian vegetation, streambank protection and the establishment of a "no-mow" filter strip.

The following is a summary of the mitigation capabilities of the three participating jurisdictions.

Table 2.12 Knox County Jurisdictions: Summary of Mitigation Capabilities

Capability	Knox County	Knoxville	Farragut
General Plan	Yes	Yes	Yes
Emergency Operations Plan	Yes	Yes	Yes
Economic Development Plan/Policy	Yes	Yes	Yes
Capital Improvements Plan	Yes	Yes	Yes
Building Code	Yes	Yes	Yes
Building Code Year	2012 IBC	2012 IBC	2006 IBC
Building Code Effectiveness Grading Schedule Rating	3-commercial 4-residential	4-commercial 4-residential	3
Fire Department ISO Rating	4-6 (varies across county)	3	4
Stormwater Management Program	Yes	Yes	Yes
Floodplain Management Ordinance	Yes	Yes	Yes
Zoning Ordinance	Yes	Yes	Yes
Subdivision Ordinance	Yes	Yes	Yes
Site plan review requirements	Yes	Yes	Yes
Erosion Management Ordinance	Yes	Yes	Yes
National Flood Insurance Program Participant	Yes	Yes	Yes
Flood insurance study	Yes	Yes	Yes
Elevation Certificates Maintained	Yes	Yes	Yes
Other special plans	Yes	Yes	Yes

Source: HMPC

3 RISK ASSESSMENT

44 CFR Requirement §201.6(c)(2): [The plan shall include] A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

The risk assessment process identifies and profiles relevant hazards and assesses the exposure of lives, property, and infrastructure to these hazards. The goal of the risk assessment is to estimate the potential loss in Knox County, including loss of life, personal injury, property damage, and economic loss, from a hazard event. The risk assessment process allows communities in Knox County to better understand their potential risk to natural hazards and provides a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

The risk assessment for Knox County and its jurisdictions followed the methodology described in the FEMA publication 386-2, *Understanding Your Risks: Identifying Hazards and Estimating Losses* (2002), which includes a four-step process:

1. Identify Hazards
2. Profile Hazard Events
3. Inventory Assets
4. Estimate Losses

This chapter is divided into four parts: hazard identification, hazard profiles, vulnerability assessment, and Summary of Key Issues.

- **Section 3.1 Hazard Identification** identifies the hazards that threaten the planning area and describes why some hazards have been omitted from further consideration.
- **Section 3.2 Hazard Profiles** discusses the threat to the planning area and describes location, extent, previous occurrences of hazard events and the probability of future occurrence.
- **Section 3.3 Vulnerability Assessment** assesses the County's total exposure to natural hazards, considering critical facilities and other community assets at risk, and assessing growth and development trends. Hazards that vary geographically across the planning area are addressed in greater detail. This section includes steps 3 and 4 from above.
- **Section 3.4 Summary of Key Issues** provides a summary of the key issues or problems identified in the Risk Assessment.

3.1 Hazard Identification

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the type…of all natural hazards that can affect the jurisdiction.

3.1.1 Review of State Hazard Mitigation Plan

The Hazard Mitigation Planning Committee (HMPC) reviewed data and discussed the impacts of each of the Hazards of Prime Concern that were included and profiled in the 2010 update to the State of Tennessee Hazard Mitigation Plan. The nine Hazards of Prime Concern that were included in the State Plan are listed alphabetically below:

- Drought
- Earthquake
- Extreme Temperatures
- Fire (Wildland/Urban.)
- Flood (Riverine/Flash)
- Geologic (Landslides/Expansive Soils/Subsidence)
- Severe Storm (Hail/Lightning/Wind/ Etc.)
- Severe Winter Storm (Snow/Ice/Etc.)
- Tornado

Data on the past impacts and future probability of these hazards in the Knox County planning area was collected from the following sources:

- Tennessee Hazard Mitigation Plan (October 2010)
- Information on past hazard events from the Spatial Hazard Event and Loss Database (SHELDUS), a component of the University of South Carolina Hazards Research Lab that compiles county-level hazard data for 18 different natural hazard event types
- Information on past extreme weather and climate events from the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center
- Disaster declaration history from the Federal Emergency Management Agency (FEMA), the Public Entity Risk Institute, and the USDA Farm Service Agency Disaster Declarations
- The National Drought Mitigation Center Drought Reporter
- Information provided by members of the Hazard Mitigation Planning Committee
- Various articles and publications available on the internet (sources are indicated where data is cited)

3.1.2 Disaster Declaration History

One method used by the HMPC to identify hazards was to examine events that triggered federal and/or state disaster declarations. Federal and/or state declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. Should the

disaster be so severe that both the local and state governments' capacities are exceeded, a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

The federal government may issue a disaster declaration through FEMA, the U.S. Department of Agriculture (USDA), and/or the Small Business Administration. FEMA also issues emergency declarations, which are more limited in scope and do not include the long-term federal recovery programs of major disaster declarations. Determinations for declaration type are based on scale and type of damages and institutions or industrial sectors affected.

A USDA disaster declaration certifies that the affected county has suffered at least a 30 percent loss in one or more crop or livestock areas and provides affected producers with access to low-interest loans and other programs to help mitigate disaster impacts. In accordance with the Consolidated Farm and Rural Development Act, counties neighboring those receiving disaster declarations are named as contiguous disaster counties and are eligible for the same assistance.

Table 3.1 lists federal disaster declarations received by Knox County. Each of the disaster events affected multiple counties; damages reflect total losses to all counties constant with 2009 dollars.

Table 3.1 Disaster Declaration History in Knox County, 1953-Present

Declaration Number	Declaration Date	Disaster Description	Counties Included	Constant 2009 $
Major Disaster Declarations				
1464	5/8/2003 (5/4/2003)	Severe Storms, Tornadoes, and Flooding	Anderson, Bedford, Benton, Bledsoe, Blount, Bradley, Cannon, Carroll, Cheatham, Chester, Cocke, Coffee, Crockett, Cumberland, Davidson, DeKalb, Decatur, Dickson, Dyer, Fayette, Gibson, Giles, Hamilton, Hardeman, Hardin, Haywood, Henderson, Henry, Hickman, Houston, Humphreys, Jefferson, **Knox**, Lake, Lauderdale, Lawrence, Lewis, Lincoln, Loudon, Macon, Madison, Marion, Marshall, Maury, McMinn, Meigs, Monroe, Montgomery, Morgan, Obion, Perry, Polk, Rhea, Roane, Robertson, Rutherford, Sequatchie, Sevier, Shelby, Smith, Stewart, Sumner, Tipton, Trousdale, Warren, Wayne, Weakley, Williamson, and Wilson .	81,276,879

Declaration Number	Declaration Date	Disaster Description	Counties Included	Constant 2009 $
1331	6/12/2000 (5/23-31/2000)	Severe Storms, Tornadoes, and Flooding	Anderson, Benton, Cheatham, Davidson, Henry, Hickman, Houston, Jackson, **Knox**, Lake, Obion, Perry, Pickett, Stewart and Weakley.	5,730,747
1215	4/20/1998 (4/16-5/18/1998)	Severe Storms, Tornadoes, and Flooding	Anderson, Blount, Bradley, Campbell, Carroll, Cheatham, Claiborne, Crockett, Davidson, Dickson, Dyer, Gibson, Giles, Grainger, Hamblen, Hancock, Hardin, Hawkins, Jefferson, **Knox**, Lawrence, Loudon, Macon, Madison, Maury, Monroe, Morgan, Pickett, Polk, Rhea, Roane, Robertson, Sevier, Shelby, Sumner, Union, Wayne, Williamson, and Wilson.	49,518,515
424	4/4/1974 (4/4/1974)	Tornadoes	Bedford, Blount, Bradley, Cannon, Carter, Clay, Coffee, Cumberland, Davidson, DeKalb, Decatur, Dickson, Fentress, Franklin, Giles, Grundy, Hamblen, Hamilton, Hancock, Hardin, Henderson, Jackson, Jefferson, Johnson, **Knox**, Lincoln, Loudon, Macon, Marion, Marshall, McMinn, Meigs, Monroe, Overton, Pickett, Polk, Putnam, Rutherford, Scott, Sullivan, Trousdale, Warren, White, Williamson, and Wilson.	14,219,241
366	3/21/1973 (3/21/1973)	Heavy Rains and Flooding	Anderson, Bedford , Bledsoe, Blount, Bradley, Cannon, Carter, Claiborne, Cocke, Coffee, Franklin, Giles, Grainger, Greene, Grundy, Hamblen, Hamilton, Hancock, Hardin, Hawkins, Hickman, Jefferson, Johnson, **Knox**, Lawrence, Lincoln, Loudon, Marion, Marshall, Maury, McMinn, Meigs, Monroe, Moore, Rhea, Roane, Rutherford, Sequatchie, Sevier, Sullivan, Unicoi, Union, Van Buren, Warren, Washington, Wayne, and White.	18,226,080
151	3/27/1963	Severe Storms and Flooding	**Knox**	3,422,821
Emergency Declarations				
3217	9/5/2005 (8/29-10/1/2005)	Hurricane Katrina Evacuation	Anderson, Bedford, Benton, Bledsoe, Blount, Bradley, Campbell, Cannon, Carroll, Carter, Cheatham, Chester, Claiborne, Clay, Cocke, Coffee, Crockett, Cumberland, Davidson, DeKalb, Decatur, Dickson, Dyer, Fayette, Fentress, Franklin, Gibson, Giles, Grainger, Greene, Grundy, Hamblen, Hamilton, Hancock, Hardeman, Hardin, Hawkins,	37,766,887

Declaration Number	Declaration Date	Disaster Description	Counties Included	Constant 2009 $
			Haywood, Henderson, Henry, Hickman, Houston, Humphreys, Jackson, Jefferson, Johnson, **Knox**, Lake, Lauderdale, Lawrence, Lewis, Lincoln, Loudon, Macon, Madison, Marion, Marshall, Maury, McMinn, McNairy, Meigs, Monroe, Montgomery, Moore, Morgan, Obion, Overton, Perry, Pickett, Polk, Putnam, Rhea, Roane, Robertson, Rutherford, Scott, Sequatchie, Sevier, Shelby, Smith, Stewart, Sullivan, Sumner, Tipton, Trousdale, Unicoi, Union, Van Buren, Warren, Washington, Wayne, Weakley, White, Williamson, and Wilson.	
3095	3/14/1993 (3/13-17/1993	Severe Snowfall and Winter Storm	Anderson, Bedford, Bledsoe, Blount, Bradley, Campbell, Cannon, Carter, Claiborne, Clay, Cocke, Coffee, Cumberland, DeKalb, Fentress, Franklin, Grainger, Greene, Grundy, Hamblen, Hamilton, Hancock, Hawkins, Jackson, Jefferson, Johnson, **Knox**, Lawrence, Lincoln, Loudon, Macon, Marion, McMinn, Meigs, Monroe, Moore, Morgan, Overton, Pickett, Polk, Putnam, Rhea, Roane, Rutherford, Scott, Sequatchie, Sevier, Smith, Sullivan, Trousdale, Unicoi, Union, Van Buren, Warren, Washington, White, and Wilson.	21,118,293

Source: Federal Emergency Management Agency, www.fema.gov/; Public Entity Risk Institute, www.peripresdecusa.org/
* Incident dates are in parentheses

Table 3.2 lists recent U.S. Department of Agriculture disaster declarations and their related causes.

Table 3.2 USDA Disaster Declarations in Knox County 2005-2007

Designation Number	Description	Termination Date
S3065	Drought and excessive heat	08/08/2011
S3055	Drought and excessive heat	07/18/2011
S3039	Drought and excessive heat	05/31/2011

Source: USDA Farm Service Agency, www.fsa.usda.gov,

The HMPC eliminated some hazards from further profiling. Manmade and technological hazards were eliminated for two reasons. First, evaluation of these hazards is not necessary for plans to meet the requirements of the Disaster Mitigation Act of 2000. Secondly, these hazards are profiled and planned for in other plans such as the Local Emergency Operations Plan and Knox County Public Health Plans.

After review of the hazards in the State Plan as well as the disaster declaration history, the HMPC identified twelve natural hazards that significantly affect the planning area. These hazards are listed below in Table 3.3 with an "X" indicating the affected jurisdictions. Each of these hazards is profiled in further detail in the next section.

Table 3.3 Hazards Identified for Each Participating Jurisdiction

Hazard	Knox County	Farragut	Knoxville
Dam Failure*	X	X	X
Drought	X	X	X
Earthquake	X	X	X
Expansive Soils	X	X	X
Extreme Temperatures	X	X	X
Flood	X	X	X
Land Subsidence and Sinkholes	X	X	X
Landslide	X	X	X
Severe Storms	X	X	X
Tornado	X	X	X
Wildfire	X	X	X
Winter Storms	X	X	X

* The HMPC chose to profile dam failure as a separate hazard from flood since dams can fail during non-flood conditions.

Multi-Jurisdictional Risk Assessment

For this multi-jurisdictional plan, the risk assessment assesses each jurisdiction's risks where they deviate from the risks facing the entire planning area. Knox County is 526 square miles and is fairly uniform in terms of climate and construction characteristics.

Accordingly, overall hazards and vulnerability do not vary greatly across the planning area for most hazards. Weather-related hazards, such as drought, extreme temperatures, severe storms, tornado, and winter storms affect the entire planning area.

The hazards that do vary across the planning area include dam failure, earthquake, flood, landslide, land subsidence/sinkholes, and wildfire. In Section 3.2, Hazard Profiles, the Geographic Location section discusses how the hazard varies among jurisdictions across the planning area in terms of location. The Previous Occurrences section lists the best available data on where past events have occurred and the associated losses to particular jurisdictions. Section 3.3.2, Community Asset Inventory, describes critical facilities and other community assets by jurisdiction. Section 3.3.3, Vulnerability by Hazard, identifies structures and estimates potential losses by jurisdiction where data is available and hazard areas are identified.

The previous chapter, Chapter 2 Planning Area Profile and Capabilities, discussed the existing mitigation capabilities of each jurisdiction, such as plans and policies, personnel, and financial resources, which are or could be used to implement measures to reduce hazard losses.

3.2 Hazard Profiles

Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the…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.

Methodology

Each hazard identified in Section 3.1 Hazard Identification is profiled individually in this section. The level of information presented in the profiles varies by hazard based on the information available. With each update of this plan, new information will be incorporated to provide for better evaluation and prioritization of the hazards that affect Knox County.

The sources used to collect information for these profiles include those mentioned in Section 3.1.1 as well as those cited individually in each hazard section.

Detailed profiles for each of the identified hazards include information categorized as follows:

Hazard Description

This section consists of a general description of the hazard and the types of impacts it may have on a community.

Geographic Location

This section describes the geographic location of the hazard in the planning area. Where available, the extent, or potential “size” of the hazard is discussed in this section. Where available, maps are utilized to indicate the specific locations within the planning area that are vulnerable to the subject hazard.

Previous Occurrences

This section includes information on historic incidents and their impacts based upon the sources described in Section 3.1 Hazard Identification and the information provided by the Hazard Mitigation Planning Committee.

Probability of Future Occurrence

Where applicable, the frequency of past events is used to gauge the likelihood of future occurrences. Where possible, the probability or chance of occurrence was calculated based on historical data. Probability was determined by dividing the number of events observed by the number of years and multiplying by 100. This gives the percent chance

of the event happening in any given year. An example would be three droughts occurring over a 30-year period, which suggests a 10 percent chance of a drought occurring in any given year.

Magnitude/Severity

The magnitude of the impact of a hazard event (past and perceived) is related directly to the vulnerability of the people, property, and the environment it affects. This is a function of when the event occurs, the location affected the resilience of the community, and the effectiveness of the emergency response and disaster recovery efforts.

Hazard Summary

At the conclusion of each hazard profile, a hazard summary table is provided for each jurisdiction in terms of the following elements: probability of future occurrence, potential magnitude, and spatial extent. The ratings of these elements were then used to calculate a planning significance rating. The assigned value, ratings, and defined parameters are provided below.

Probability of Future Occurrence

4-Highly Likely: Near 100% probability in next year.

3- Likely**:** Between 10 and 100% probability in next year or at least one chance in ten years.

2- Occasional**:** Between 1 and 10% probability in next year or at least one chance in next 100 years.

1- Unlikely**:** Less than 1% probability in next 100 years.

Potential Magnitude

4- Catastrophic**:** Multiple deaths, complete shutdown of facilities for 30 or more days, more than 50 percent of property is severely damaged

3- Critical**:** Injuries and/or illnesses result in permanent disability, complete shutdown of critical facilities for at least two weeks, 25–50 percent of property is severely damaged.

2- Limited: Injuries and/or illnesses do not result in permanent disability, complete shutdown of critical facilities for more than one week, 10–25 percent of property is severely damaged.

1- Negligible**:** Injuries and/or illnesses are treatable with first aid, minor quality of life lost, shutdown of critical facilities and services for 24 hours or less, less than 10 percent of property is severely damaged

Spatial Extent

***3- Extensive*:** 50-100% of planning area

***2- Significant*:** 10-50% of planning area

***1- Limited*:** Less than 10% of planning area

Planning Significance

The HMPC determined that the frequency of occurrence is the most relevant element in determining overall significance, followed by potential magnitude and then spatial extent. Therefore, the following formula was utilized to appropriately weight these elements and determine overall planning significance.

Frequency of Occurrence (.45) X Potential Magnitude (.35) X Spatial Extent (.20) = Planning Significance Score

1-1.99 = Low; 2-2.99 = Medium;3-4 = High

Based on the above methodology, Table 3.4 provides the ratings and planning significance scores for the hazards analyzed in this plan. These planning significance scores are for the planning area as a whole. The hazard summary section at the end of each hazard profile provides separate planning significance scores for each jurisdiction.

Table 3.4 Planning Significance Scores

Hazard	Probability	Magnitude	Spatial Extent	Planning Significance	Ranking
Dam Failure	1	2	2	1.55	Low
Drought	2	2	1	1.8	Low
Earthquake	3	1	3	2.3	Medium
Expansive soils	1	1	1	1	Low
Extreme Temperatures	4	2	3	3.1	High
Flood	4	2	3	3.1	High
Land subsidence and sinkholes	4	2	2	2.9	Medium
Landslides	3	2	2	2.45	Medium
Severe Storms	4	2	3	3.1	High
Tornado	3	2	1	2.25	Medium
Wildfires	4	1	1	2.35	Medium
Winter Storms	4	1	3	2.75	Medium

3.2.1 Dam Failure

Description

A dam is defined as a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water. Dams are typically constructed of earth, rock, concrete, or mine tailings. A dam failure is the collapse, breach, or other failure resulting in downstream flooding.

A dam impounds water in the upstream area, referred to as the reservoir. The amount of water impounded is measured in acre-feet. An acre-foot is the volume of water that covers an acre of land to a depth of one foot. As a function of upstream topography, even a very small dam may impound or detain many acre-feet of water. Two factors influence the potential severity of a full or partial dam failure: the amount of water impounded, and the density, type, and value of development and infrastructure located downstream.

The failure of dams could result in injuries, loss of life, or damage to property, the environment, and the economy. Dams often serve multiple purposes, one of which may be flood control. Severe flooding and other storms can increase the potential that dams will be damaged and fail as a result of the physical force of the flood waters or overtopping.

Dams are usually engineered to withstand a flood with a computed risk of occurrence. If a larger flood occurs, then that structure will likely be overtopped. If during the overtopping, the dam fails or is washed out, the water behind is released as a flash flood. Failed dams can create floods that are catastrophic to life and property, in part because of the tremendous energy of the released water.

The hazard potential for dam failure is classified according to the following definitions accepted by the Interagency Committee on Dam Safety:

- **High Hazard Dam**—A dam located in an area where failure could result in any of the following: extensive loss of life, damage to more than one home, damage to industrial or commercial facilities, interruption of a public utility serving a large number of customers, damage to traffic on high-volume roads that meet the requirements for hazard class C dams or a high-volume railroad line, inundation of a frequently used recreation facility serving a relatively large number of persons, or two or more individual hazards described for significant hazard dams
- **Significant Hazard Dam**—A dam located in an area where failure could endanger a few lives, damage an isolated home, damage traffic on moderate volume roads that meet certain requirements, damage low-volume railroad tracks, interrupt the use or service of a utility serving a small number of customers, or inundate recreation

facilities, including campground areas intermittently used for sleeping and serving a relatively small number of persons
- **Low Hazard Dam**—A dam located in an area where failure could damage only farm or other uninhabited buildings, agricultural or undeveloped land including hiking trails, or traffic on low-volume roads that meet the requirements for low hazard dams

Dam failures can result from any one or a combination of the following causes:

- Prolonged periods of rainfall and flooding, which causes most failures;
- Inadequate spillway capacity, resulting in excess overtopping flows;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, replace lost material from the cross section of the dam and abutments;
- Improper design, including the use of improper construction materials and construction practices;
- Negligent operation, including failure to remove or open gates or valves during high flow periods;
- Failure of upstream dams o the same waterway;
- Landslides into reservoirs, which cause surges that result in overtopping;
- High winds, which can cause significant wave action and result in substantial erosion; and
- Earthquakes, which typically cause longitudinal cracks at the tops of embankments and weaken entire structures.

Geographic Location

According to data from the National Inventory of Dams, Knox County has one state-regulated dam, the Victor Ashe Dam, located within the City of Knoxville, which is a significant low hazard dam. In addition, outside and upstream of Knox County, there are 7 federal dams regulated by the Tennessee Valley Authority (TVA) that would impact portions of the planning area in the event of failure.

Victor Ashe Dam

The state-regulated dam is owned by the City of Knoxville. It is on a tributary of Third Creek. It is 30 feet high and 309 feet long with a drainage area of .143 square miles and a maximum storage of 25 acre feet. Victor Ashe Dam is displayed in Figure 3.1.

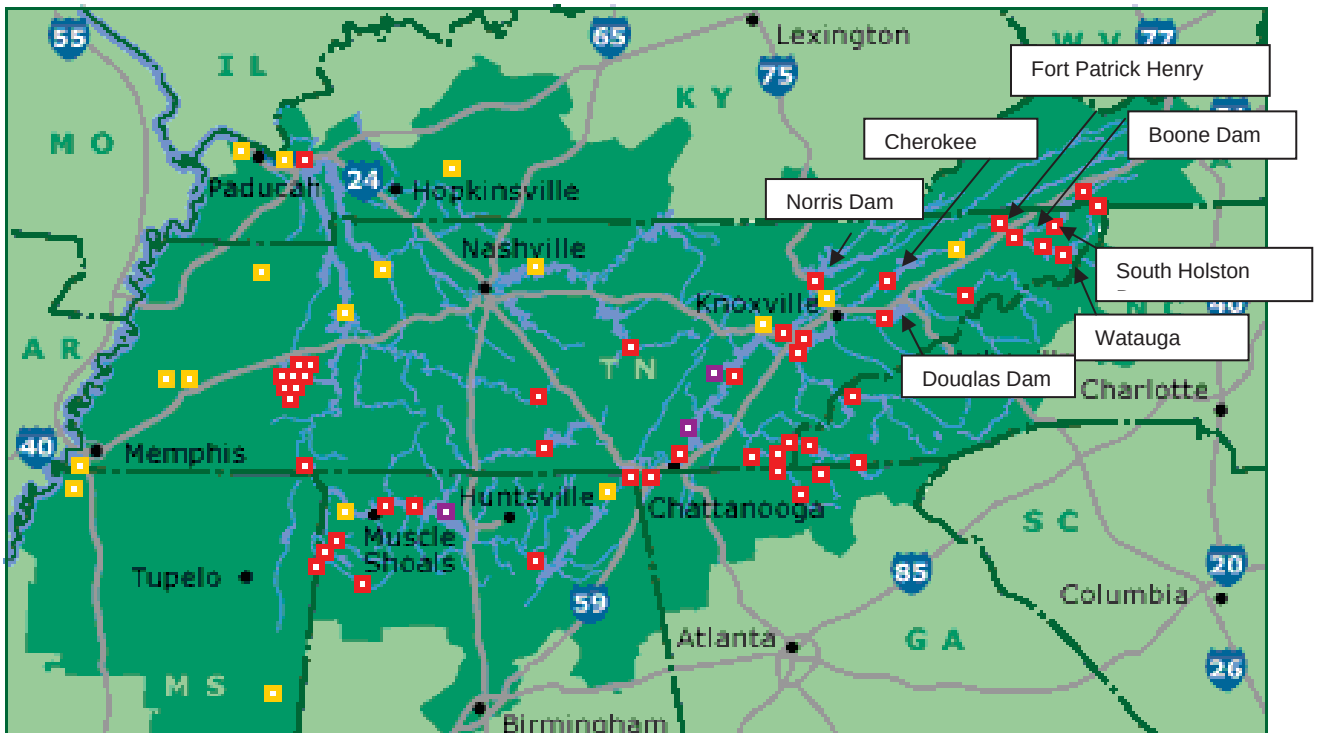
Figure 3.1. **Victor Ashe Dam in Knox County, Knoxville, Tennessee**

The upstream federal dams regulated by the TVA that could impact Knox County in the event of failure are listed in Table 3.5 and displayed in Figure 3.2.

Table 3.5 Upstream Federal Dams

Dam	River	City
Cherokee Dam	Holston River	Jefferson City, TN
Douglas Dam	French Broad River	Sevierville, TN
Fort Patrick Henry Dam	South Fork Holston River	Kingsport, TN
Boone Dam	South Fork Holston River	Kingsport, TN
South Holston Dam	South Fork Holston River	Bristol, TN
Norris Dam	Clinch River	Lake City, TN
Watauga Dam	Watauga River	Elizabethton, TN

Figure 3.2. **Upstream Federal Dam Locations**



Source: Tennessee Valley Authority, http://www.tva.gov

Cherokee Dam

Cherokee Dam is on the Holston River in east Tennessee, 52 miles upstream from the point at which the Holston and French Broad Rivers converge to form the Tennessee River. Construction of Cherokee Dam began in August 1, 1940, and was completed on a crash schedule on December 5, 1941. The reservoir has nearly 400 miles of winding

shoreline and about 28,780 acres of water surface. The dam is 175 feet high and stretches 6,760 feet, or well over a mile, from one end to the other. In a year with normal rainfall, the water level in Cherokee Reservoir varies about 30 feet from summer to winter to provide seasonal flood storage. Cherokee has a flood-storage capacity of 749,400 acre-feet. The hydroelectric power plant at Cherokee Dam consists of four generating units.

Figure 3.3. **Cherokee Dam**

Source: Tennessee Valley Authority, http://www.tva.gov/sites/cherokee.htm

Douglas Dam

Douglas Dam is on the French Broad River in east Tennessee. The reservoir extends 43 miles upriver from the dam through the foothills of the Great Smoky Mountains. Work on Douglas Dam began in February 1942 and was completed on a crash schedule in just 12 months and 17 days. The construction of Douglas set a world record for projects of equivalent size. The dam is 202 feet high and stretches 1,705 feet across the French Broad River. Douglas Reservoir provides 513 miles of shoreline and about 28,420 acres of water surface for recreation activities. In a year with normal rainfall, the water level in Douglas Reservoir varies about 44 feet from summer to winter to provide seasonal flood storage. The reservoir has a flood-storage capacity of 1,082,000 acre-feet. The hydroelectric power plant at Douglas Dam consists of four generating units.

Figure 3.4. **Douglas Dam**

Tennessee Valley Authority, http://www.tva.gov/sites/douglas.htm

Fort Patrick Henry Dam

Fort Patrick Henry Reservoir, on the South Fork Holston River in east Tennessee, extends 10 miles upstream from the dam to Boone Dam. Construction of Fort Patrick Henry Dam began in 1951 and was completed in 1953. The dam is 95 feet high and stretches 737 feet across the South Fork Holston River. Fort Patrick Henry is a run-of-river reservoir, meaning that water is passed through the reservoir without being stored long term. TVA typically maintains the water level between 1,258 and 1,263 feet of elevation. The hydroelectric power plant at Fort Patrick Henry Dam consists of two generating units

Figure 3.5. **Fort Patrick Henry Dam**

Source: Tennessee Valley Authority, http://www.tva.gov/sites/fortpatrickhenry.htm

Boone Dam

Boone Reservoir is located on the South Fork Holston River in northeast Tennessee. Construction of Boone Dam began in 1950 and was completed in 1952. The dam is 160 feet high and stretches 1,532 feet across the South Fork Holston River. In a year with

normal rainfall, the water level in Boone Reservoir varies about 25 feet from summer to winter to provide seasonal flood storage. The reservoir has a flood-storage capacity of 75,800 acre-feet. The hydroelectric power plant at Boone Dam consists of three generating units.

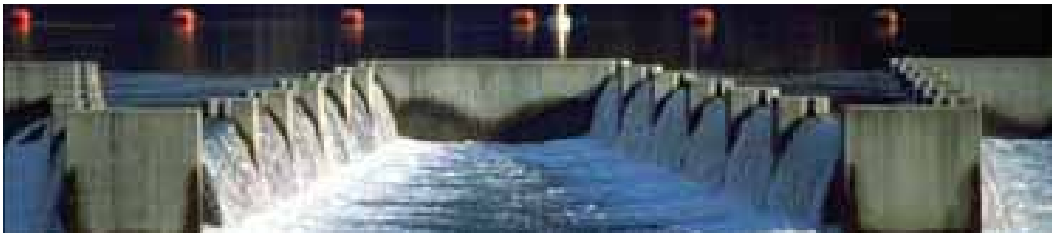
Figure 3.6. **Boone Dam**

Source: Tennessee Valley Authority, http://www.tva.gov/sites/boone.htm

South Holston Dam

Construction of South Holston Dam began in 1942 and was completed in 1950. The earth-and-rockfill dam is 285 feet high and reaches 1,600 feet across the South Fork Holston River. In a year with normal rainfall, the water level in South Holston Reservoir varies about 25 feet from summer to winter to provide seasonal flood storage. The reservoir has a flood-storage capacity of 252,800 acre-feet. The hydroelectric power plant at South Holston Dam has one generating unit.

Figure 3.7. **Weir Structure at South Holston Dam**



Source: Tennessee Valley Authority, http://www.tva.gov/sites/sholston.htm

Norris Dam

Norris Reservoir in east Tennessee extends 73 miles up the Clinch River and 56 miles up the Powell from Norris Dam. Construction of Norris Dam began in 1933, just a few months after the creation of TVA, and was completed in 1936. The dam is 265 feet high and stretches 1,860 feet across the Clinch River. The town of Norris was built to house

construction workers on the dam. It was a planned community that became a model for others throughout the nation. The town was sold to private owners in 1948. Norris has 809 miles of shoreline and 33,840 acres of water surface. It is the largest reservoir on a tributary of the Tennessee River. In a year with normal rainfall, the water level in Norris Reservoir varies about 29 feet from summer to winter to provide seasonal flood storage. The reservoir has a flood-storage capacity of 1,113,000 acre-feet. The hydroelectric power plant at Norris Dam consists of two generating units.

Figure 3.8. **Norris Dam**

Source: Tennessee Valley Authority, http://www.tva.gov/sites/norris.htm

Watauga Dam

Watauga Reservoir is in northeast Tennessee near Elizabethton. The reservoir extends 16 miles east from Watauga Dam toward the North Carolina border. Construction of Watauga Dam began in early 1942 but was curtailed later that year in favor of other wartime building efforts. Work resumed in 1946, and the dam was completed in 1948. Watauga Dam is 318 feet high and extends 900 feet across the Watauga River. In a year with normal rainfall, the water level in the reservoir varies about 11 feet from summer to winter to provide for seasonal flood storage. Watauga has a flood-storage capacity of 152,800 acre-feet. The hydroelectric power plant at Watauga Dam consists of two generating units.

Figure 3.9. **Watauga Dam**

Source: Tennessee Valley Authority, http://www.tva.gov/sites/watauga.htm

Previous Occurrences

There have been no reported previous occurrences of dam failure in or impacting Knox County.

Probability of Future Occurrences

Because dam failure is generally a secondary effect of other causes and hazards, calculating probability is difficult. Based on the past performance of these structures during flooding conditions, the HMPC determined that the probability of this hazard is "unlikely".

Magnitude/Severity

Although there have been no documented failures of dams that could impact Knox County and the probability of failure is low, if failure were to occur, people and structures in the inundation path would be at risk. There is only one dam in the planning area, Victor Ashe Dam. Additionally, the TVA dams are all well upstream of Knox County. The HMPC determined that the magnitude would be "limited"

Dam Failure Hazard Summary

The planning significance elements for unincorporated Knox County and the City of Knoxville are the same as those determined for the planning area as a whole. However, for the Town of Farragut, this hazard varies in terms of magnitude and Spatial Extent. The upstream TVA dams that could impact the planning area are farther away from the Town of Farragut, than the rest of the planning area. In addition, the only state-regulated dam is within the city limits of Knoxville. Therefore, both the magnitude and spatial extent of dam failure were considered to be negligible for the Town of Farragut.

	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	1-Unlikely	2-Limited	2-Significant	1.55 (Low)
Knox County (unincorporated)	1-Unlikely	2-Limited	2-Significant	1.55 (Low)
City of Knoxville	1-Unlikely	2-Limited	2-Significant	1.55 (Low)
Town of Farragut	1-Unlikely	1-Negligible	1-Limited	1.00 (Low)

3.2.2 Drought

Description

A drought is a period of drier-than-normal conditions that result in water-related problems. Precipitation (rain or snow) falls in uneven patterns across the country. The amount of precipitation at a particular location varies from year to year but, over a period of years, the average amount is fairly constant. The average monthly precipitation for Knoxville, Knox County, is presented in Table 3.6 below.

Table 3.6 Average Monthly Precipitation (inches), 1971-2000

Month	Precipitation
January	4.57in.
February	4.01in.
March	5.17in.
April	3.99in.
May	4.68in.
June	4.04in.
July	4.71in.
August	2.89in.
September	3.04in.
October	2.65in.
November	3.98in.
December	4.49in
Total	48.22in

Source: RSS Weather.com, http://www.rssweather.com/climate/Tennessee/Knoxville/

When no rain or only a very small amount of rain falls, soils can dry out and plants can die. When rainfall is less than normal for several weeks, months or years, the flow of streams and rivers declines and the water levels in lakes reservoirs and wells fall. If dry weather persists and water-supply problems develop, the dry period can become a drought. Lower river levels can also cause transportation interruptions on navigable streams as well as a decrease in electricity generation at hydropower plants that supply power to the planning area.

According to the State of Tennessee Drought Management Plan (2010), there are three principal types of droughts:

1) *Hydrologic drought* is characterized by extreme low flows of streams and declining groundwater levels, but does not severely impact the production of crops. Hydrologic droughts reflect reduced precipitation over an extended period of time. The absence of rainfall, particularly during the winter and early spring when evapotranspiration is

low and ground water resources typically recharge, can result in hydrologic conditions producing low streamflows.

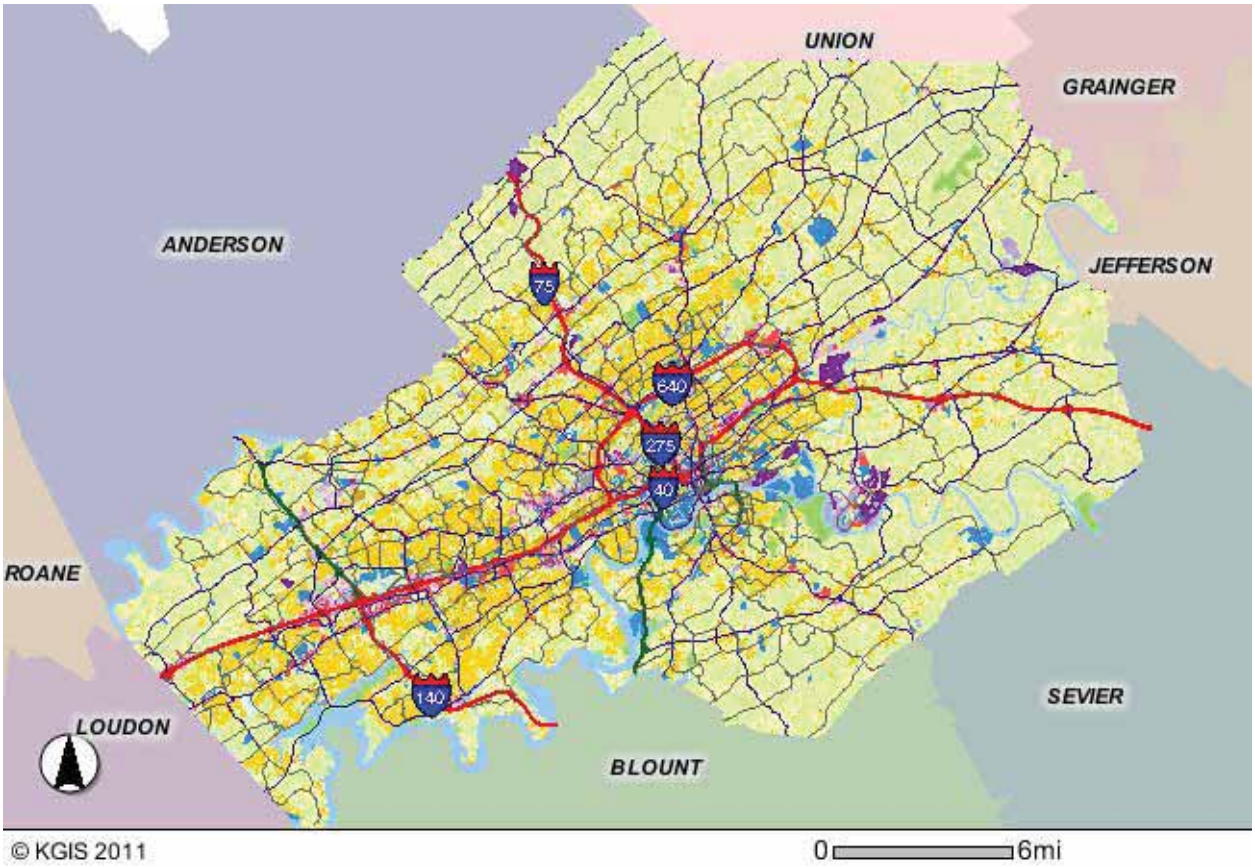
2) *Agricultural drought* occurs when soil moisture is insufficient to meet the needs of a particular crop during its growing season. In Tennessee, an agricultural drought severely impacts crop, hay and nursery production. An agricultural drought would also stress lawns, golf courses, and athletic fields.
3) *Socioeconomic drought* occurs when the demand for goods or services exceeds the available supply as a result of precipitation conditions. Agricultural, hydroelectric generation and water supply impacts are the most obvious effects of drought; however, there are many others that are less obvious. For example, drought can lower basin water levels, which can slow, and sometimes halt, commercial shipping that is vital to the region.

The beginning of a drought is difficult to determine. Several weeks, months, or even years may pass before people recognize that a drought is occurring. The end of a drought can occur as gradually as it began. Dry periods can last for 10 years or more. The first evidence of drought usually is seen in records of rainfall. Within a short period of time, the amount of moisture in soils can begin to decrease. The effects of a drought on flow in streams and rivers or on water levels in lakes and reservoirs may not be noticed for several weeks or months. Water levels in wells may not reflect a shortage of rainfall for a year or more after a drought begins.

Geographic Location

Drought tends to affect broad regions and the entire planning area is subject to drought occurrence at roughly equal probability. The impacts of prolonged drought are most significant in agricultural areas of the County. According to the 2007 Census of Agriculture, 82,938 acres in Knox County are used for agricultural purpose. This translates to 25.5 percent of the 325, 120 land acres in the County. Figure 3.10 provides the current land use in Knox County. The lightest green areas are a mixture of agricultural, forested, and vacant land areas.

Figure 3.10. **Knox County, Tennessee Land Use Map**



Source: KGIS, Knox NetWhere, http://www.kgis.org/knoxnetwhere

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Drought can severely limit public water supplies due to depletion of natural water sources and greatly increased demand. Problems due to limited treatment capacity or limited distribution system capacity are an additional concern. Drought can also impact hydroelectric generation.

Previous Occurrences

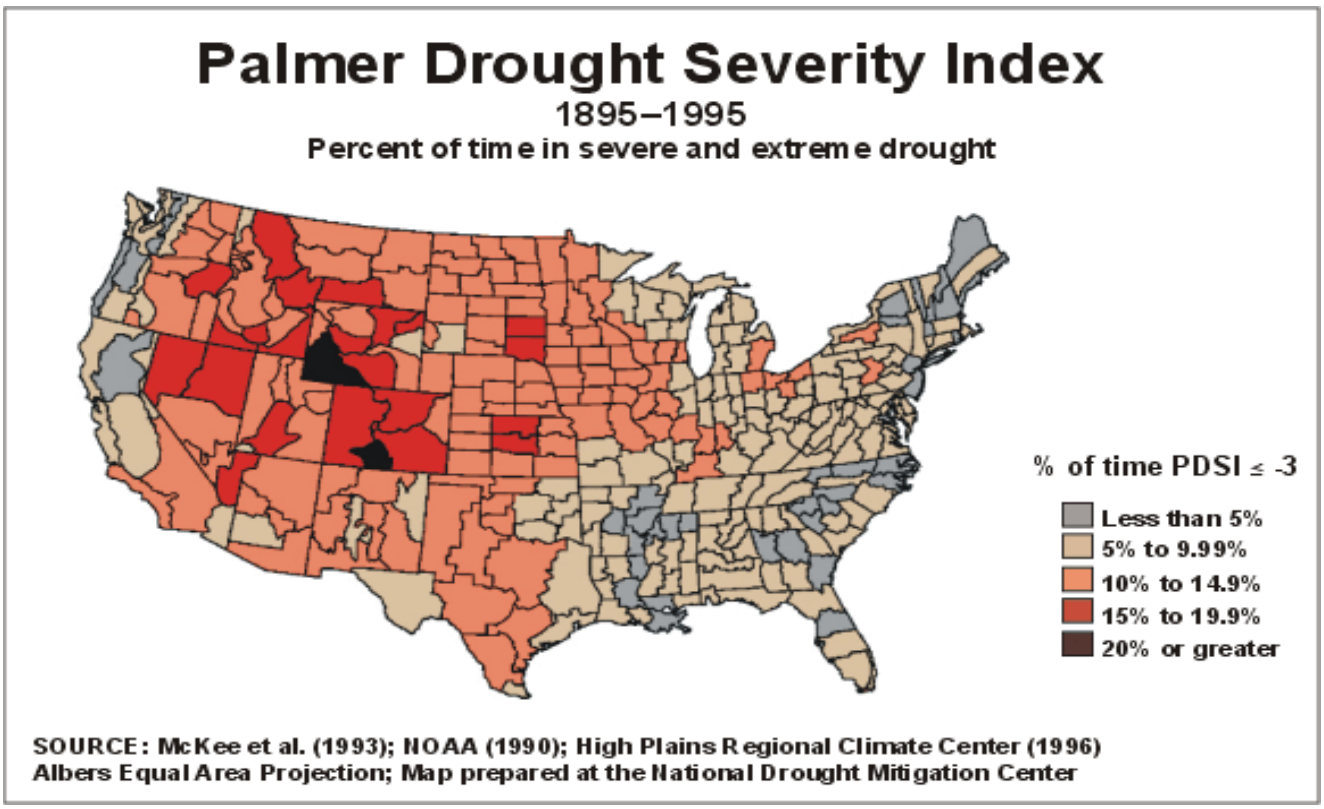
A common indicator of drought is the Palmer Drought Severity Index (PDSI). The PDSI is a soil moisture algorithm calibrated for relatively homogeneous regions. It is used by many U.S. government agencies and states to trigger drought relief programs. It was also the first comprehensive drought index developed in the United States. The classifications of the PDSI are presented in Table 3.7 below.

Table 3.7 Palmer Classifications

Palmer Classifications	
4.0 or more	extremely wet
3.0 to 3.99	very wet
2.0 to 2.99	moderately wet
1.0 to 1.99	slightly wet
0.5 to 0.99	incipient wet spell
0.49 to -0.49	near normal
-0.5 to -0.99	incipient dry spell
-1.0 to -1.99	mild drought
-2.0 to -2.99	moderate drought
-3.0 to -3.99	severe drought
-4.0 or less	extreme drought

The PDSI indicates that for the period of 1895 through 1995 the eastern portion of Tennessee, including Knox County, was in a severe to extreme drought 5 to 9.99 percent of the time (Figure 3.11).

Figure 3.11. **Palmer Drought Severity Index, 1895-1995**



Historical information on previous periods of drought and drought impacts was obtained from four primary sources, the USDA Secretarial disaster designations for drought, University of Nebraska's National Drought Mitigation Centers Drought Impact Reporter, the National Oceanic Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC). And the 2010 Tennessee Drought Management Plan.

- **2010**—In June 2010, Knox County was one of two counties included as a primary county in a USDA Secretarial Declaration for drought and excessive heat. That same month, Knox County was also included as a contiguous county in two additional USDA Secretarial Declarations for drought and excessive heat.
- **2007-2008**—This two-year drought marked the worst in recent history in Knox County, and Tennessee. In excess of 500,000 people in Tennessee were on community water systems that imposed mandatory water restrictions. Despite the severity of the 2007 drought, because of the planning that had been done, the interconnection between systems, and the communication and collaboration among agencies and water systems, only one community water system in Marion County, ran completely out of water. Although they did not ultimately run out of water, two water districts in Knox County (Luttrell Blaine Corryton Utility District (LBCUD) and

the First Utility District (FUD) requested that their users voluntarily conserve water, due to the continuing drought conditions.

Tennessee Valley Authority's hydropower generation was 50 percent below the projected amount for 2008 as the two-year drought reduced the volume of water available for power generation. The area has been in drought for the past two years

Figure 3.12 shows the impact of drought on Cherokee Lake which is upstream of Knox County.

Figure 3.12. **Cherokee Lake, upstream of Knox County, TN—September 2007**

Source: Brian Boyd, NWS, September 12. 2007,
http://www.drought.unl.edu/gallery/2007/Tennessee/cherokeeatus25e1.htm

Thirty-nine Tennessee counties, including Knox County were declared to be a natural disaster area by the U.S. Department of Agriculture, due to drought. Similar to other ranchers in the area, a Knoxville area farmer sold 80 of his 100 cows because he can't afford to feed them any longer because of the drought.

- **1986-1987 Drought**—The drought of 1986-87 is still considered one of the worst droughts in recorded Tennessee history. During that period, thousands of people were without water and there were serious ecological impacts as a result of the drought. However, the severity of the 1986-87 drought impacts did not approach the impacts experienced by many community water systems during previous droughts. This was due, in large part, to an improved awareness of source capabilities and uses, improved preparedness and higher standards of water service to communities.

- **1930s, 1943-44 and mid-1950's Droughts**—The droughts of the1930s, 1943-1944, and mid-50s resulted in impacts primarily on agriculture. By the mid-80s much of the economy of Tennessee had changed, with less reliance on agriculture and more attention given to aquatic life, the environment, industry and power production. At the same time, the cumulative demands – navigation, recreation, power production, etc. - that people have placed on a given reach of water have increased tremendously. Responding to those demands becomes particularly challenging during a period of drought.

Table 3.8 indicates the previous years as well as number of months each year from January 1950 to January 2011 when the Palmer Drought Severity Index was -3.00 or less. This index rating equates to severe and extreme drought. In total, during this 61-year period (732 months), eastern Tennessee was in severe to extreme drought for 53 months. This equates to 7.2 percent of the time.

Table 3.8 Years and Number of Months with PDSI ≤ -3.00, Tennessee-Eastern Climate Division

Year	Number of Months with PDSI ≤ -.3
2008	10 months
2007	7 months
1988	8 months
1987	4 months
1986	9 months
1981	3 months
1955	1 month
1954	6 months
1953	3 months
1952	2 months

Source: National Climatic Data Center, http://www7.ncdc.noaa.gov/CDO/CDODivisionalSelect.jsp#

According to the USDA's Risk Management Agency, insured crop losses in Knox County as a result of drought conditions from 2001 to 2010 totaled $32,240. According to the 2010 Tennessee Crop Insurance Profile, 82 percent of insurable crops were insured. Crop insurance claims as a result of drought during the 10-years period available are detailed in Table 3.9 below.

Table 3.9 Claims Paid in Knox County for Crop Loss as a Result of Drought (2001-2010)

Year	Crop	Hazard	Claims Paid
2010	Other Crops	Drought	$3,715
2007	BURLEY TOBACCO	Drought	$2,736
2007	Other Crops	Drought	$2,420
2005	BURLEY TOBACCO	Drought	$2,873
2002	BURLEY TOBACCO	Drought	$17,777

2001	BURLEY TOBACCO	Drought	$2,719
Total			**$32,240**

Source: USDA Risk Management Agency, 2011

Probability of Future Occurrences

Lack of precipitation for a given area is the primary contributor to drought conditions. Since precipitation levels cannot be predicted in the long term, it is difficult to determine the probability of future occurrences of drought. The data available from NCDC for the 61 year period from 1950 to 2011 indicates that Eastern Tennessee, including Knox County experiences drought 7.2 percent of the time. Considering this historical data as well as more recent periods of drought, the HMPC determined the probability of future occurrence of drought to be "occasional".

Magnitude/Severity

Although droughts can have a negative impact on the planning area in terms of crop production, increased wildfire threat, and possible water-use restrictions, modern impacts are not as devastating as historical impacts. Knox County, along with the rest of the State of Tennessee has transformed from an agricultural-based economy in the 40s and 50s to a more urban one. That transformation has been paralleled by the modernization of the community water systems. More water systems have become interconnected; and larger, more reliable sources are being utilized to support water systems.

The HMPC determined the magnitude/severity of drought on the planning area to be "limited"

Drought Hazard Summary

Impacts of drought do not vary significantly within the planning area. Therefore, the hazard summary elements are rated the same for all jurisdictions, resulting in the same planning significance for this hazard.

	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	2-Occaisonal	2-Limited	1-Limited	1.8 (Low)
Knox County (unincorporated)	2-Occaisonal	2-Limited	1-Limited	1.8 (Low)
City of Knoxville	2-Occaisonal	2-Limited	1-Limited	1.8 (Low)
Town of Farragut	2-Occaisonal	2-Limited	1-Limited	1.8 (Low)

3.2.3 Earthquake

Description

An earthquake is a shaking or trembling of the earth's surface caused by the lifting, shifting, breaking, or slipping of a fault line. Stresses in the earth's outer layer push the sides of the fault together. Stress builds up and the rocks slip suddenly, releasing energy in waves that travel through the earth's crust and cause the shaking that is felt during an earthquake.

Central and southeast United States earthquakes are being monitored and researched by multiple sources such as the U.S. Geological Survey, Center for Earthquake Research and Information at the University of Memphis, Central United Stated Earthquake Consortium, St. Louis University, and the University of Kentucky. Several methods have been developed to quantify the strength of an earthquake. The most recognized methods for measuring earthquake strength are:

Richter Magnitude is a measure of earthquake strength or the amount of energy released. This scale was originally developed by Charles Richter in 1935. Magnitude is expressed in whole numbers and decimals, with each succeeding whole number representing a tenfold increase in the energy released. There is only one Richter value calculated for the epicenter of a specific earthquake. The epicenter is the location on the surface of the earth directly above where an earthquake originates. It is determined by measuring the amplitudes of ground motion on seismograms.

Modified Mercalli Intensity Scale is an evaluation of the severity of ground motion at a given location measured relative to the effects of the earthquake on people and property. This scale was developed by Wood and Nueman in 1931, based on Mercalli's 1902 original version. Intensity is expressed in Roman numerals I – XII. The Mercalli scale is the most effective means of determining the approximate magnitude of a quake that occurred in historic time prior to the advent of uniform seismic detection devices and the Richter Scale.

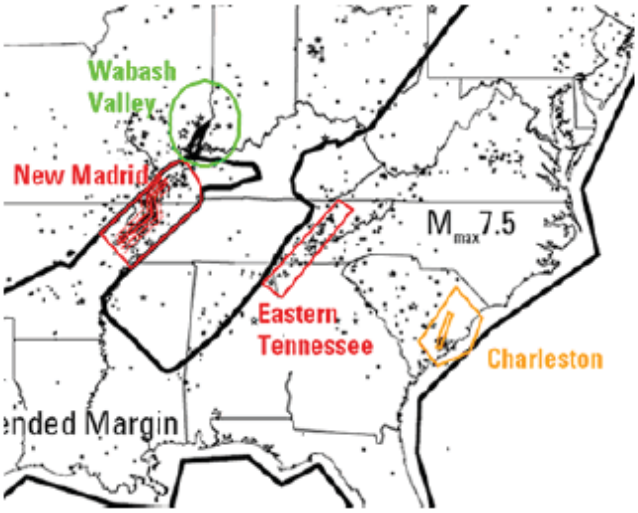
Table 3.10 Comparison of Richter Magnitude and Modified Mercalli Intensity Scales

Richter Magnitude	Modified Mercalli Scale	Effects
2	I – II	Usually detected only by instruments
3	III	Felt Indoors
4	IV – V	Felt by most people; slight damage
5	VI – VII	Felt by all; damage moderate
6	VII – VIII	Damage moderate to major
7	IX – X	Major damage
8+	X - XII	Total and major damage

Geographic Location

The southern Appalachians contain one of the most active seismic zones in eastern North America and the Knox County planning area is located in this active seismic zone. The belt of seismicity ranges from northeastern Alabama, northwestern Georgia and much of eastern Tennessee and it is called the East Tennessee Seismic Zone (ETSZ). It is a 50 kilometer-wide and 300 kilometer-long zone. See Figure.

Figure 3.13. **Central and Southeastern U.S. Seismic Zones**

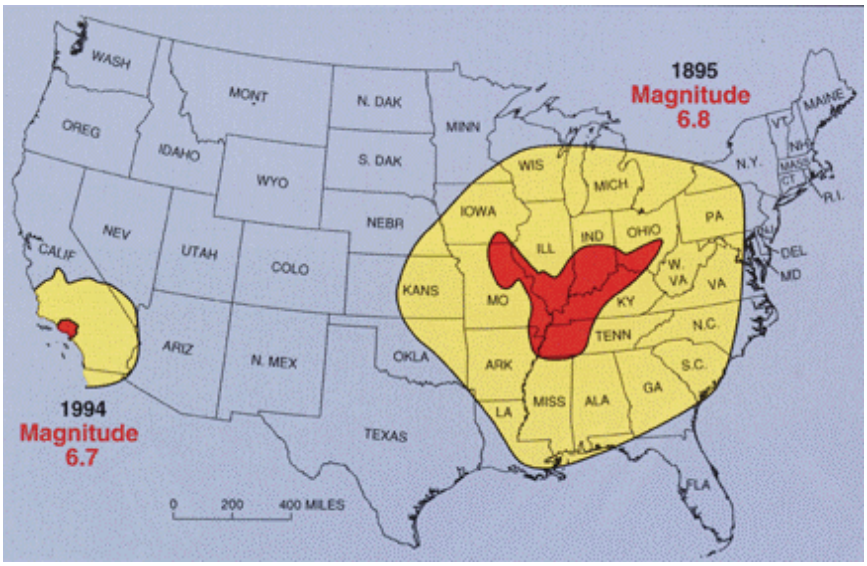


Source: Geology.com

Another earthquake scenario of concern to mention is an earthquake originating in the New Madrid Seismic Zone. This seismic zone is located near the Mississippi River in southeastern Missouri, northeastern Arkansas, western Tennessee, western Kentucky and southern Illinois (see Figure 3.13 above). Any earthquake originating here is likely to be extremely powerful, and its effects will most likely reach Knox County.

As shown in Figure 3.14, an earthquake affects a much larger area around the New Madrid Seismic Zone than an earthquake of a similar magnitude on the west coast. This is due to the differences in the geology on the eastern part of the country. In Figure 3.14 the red area near the epicenters represents damage to buildings, while the surrounding yellow area represents shaking felt, but little damage to objects. Thus Knox County, Tennessee being located in the yellow area, will feel the effects of a major New Madrid earthquake.

Figure 3.14. **Variance of Areas Impacted by the Northridge, CA Earthquake and the Charleston, MO Earthquake.**

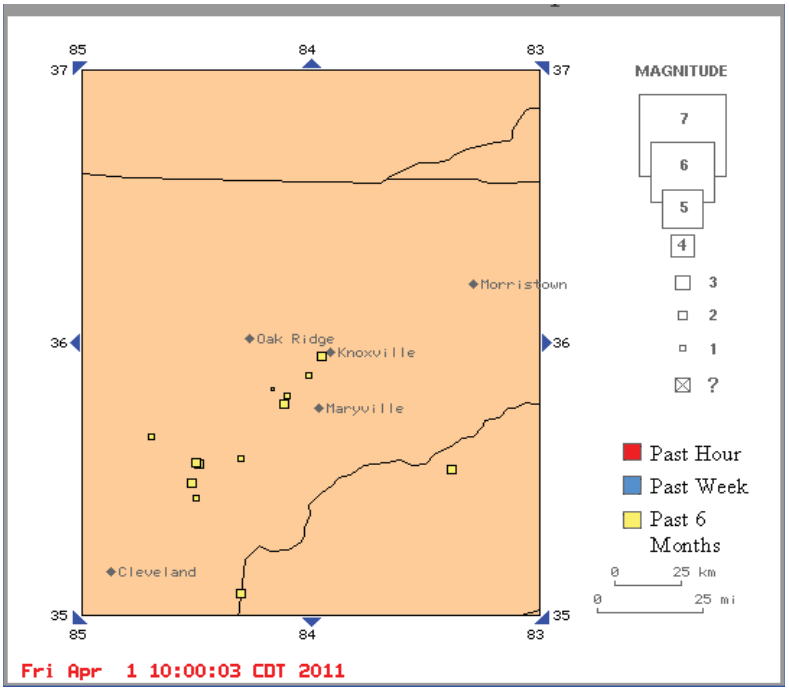


Source: Schweig, E., Gomberg, J., and Hendley, J.W., 1995, The Mississippi Valley-"Whole Lotta Shakin' Goin' On", USGS. Fact Sheet-168-95. United States Geologic Survey.

Previous Occurrences

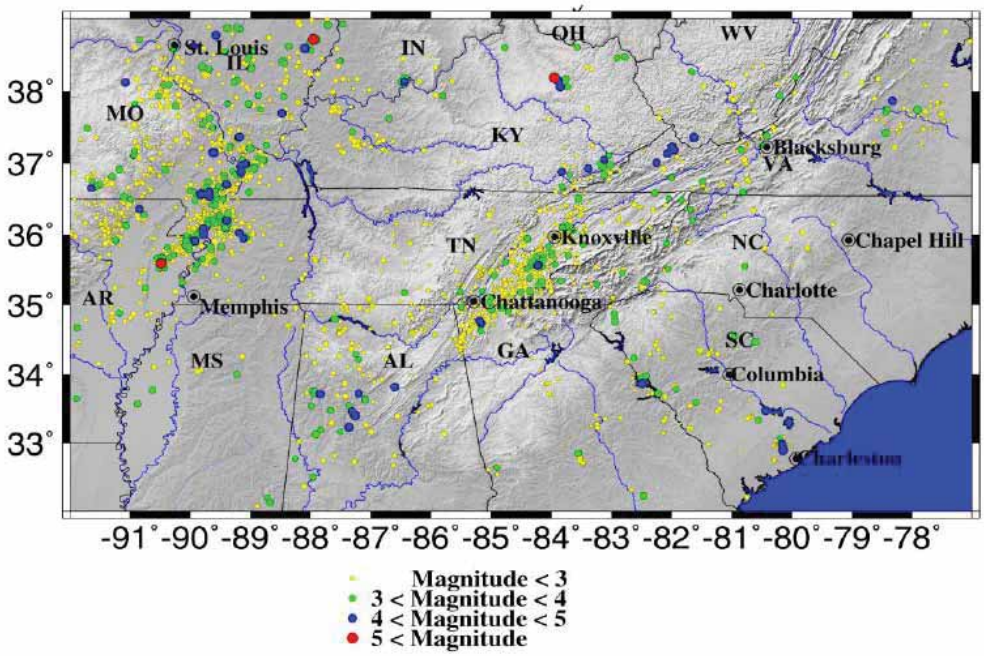
As stated, the ETSZ is a very active seismic zone and there are numerous minor earthquakes within a 50-mile radius of Knox County. As shown in Figure 3.15 and Figure 3.16, the Center for Earthquake Research and Information at the University of Memphis has been recording earthquakes in central and southeast U.S. for several decades. Figure 3.15 displays 13 recent earthquake tremors in the Knox County vicinity within the six month timeframe of October 2010 through March 2011. None of these recent earthquakes had a magnitude over 2.5. Figure 3.16 shows the recorded earthquakes from 1970-1999. The highest magnitude earthquake during this 30-year period was a 4.0 causing slight damage.

Figure 3.15. **Recent Earthquakes in Central U.S. (October 2010 through March 2011)**



Source: Center for Earthquake Research and Information at the University of Memphis
http://folkworm.ceri.memphis.edu/recenteqs/Maps/84-36.html

Figure 3.16. **Southeast U.S. Seismicity Activity Recorded from 1970-1999**



Source: Center for Earthquake Research and Information at the University of Memphis
http://www.ceri.memphis.edu/seismic/images/SE_epi.gif

The following list shows the major events sited from the U.S. Geological Survey's Earthquake Hazards Program and the Tennessee State Hazard Mitigation Plan that caused slight to moderate damage in Knox County from the ETSZ:

- **July 10, 1987**—A light earthquake measuring 3.8 and mild aftershock less than three hours later measured at 3.5 on the Richter scale. The tremors were centered about five miles northwest of the East Knox County community of Mascot. No damages and no power outages were reported from the tremors (source: *The Knoxville News-Sentinel*, July 12, 1987).
- **February 14, 1984**—This 3.8 magnitude earthquake was one of the most recent and largest intensities felt in Knoxville (Modified Mercalli Intensity VI). Windows were broken in Blaine and New Market (20 miles and 25 miles, respectively, northeast of Knoxville). No structural damage occurred.
- **October 1973**—An earthquake sequence consisting of one foreshock, a magnitude 4.6 main shock, and more than 30 aftershocks occurred south of Knoxville during the latter part of 1973. The foreshock, magnitude 3.4, on October 30, was felt over an area of 2,100 square kilometers (≈ 811 square miles), with a maximum Modified Mercalli Intensity V to VI. The main shock caused minor damage (VI) in several towns in eastern Tennessee, Georgia, Kentucky, and North Carolina. Minor cracks in walls at the University of Tennessee Hospital at Knoxville were reported. Minor damage to walls, windows, and chimneys occurred in the Maryville - Alcoa area. The *Knoxville News Sentinel* summarized the earthquake by saying "Chimneys were cracked, dishes broken, but no major damage was reported." The shock disrupted relay contacts at the Alcoa switching station, causing a temporary loss of power. The total felt area, including parts of South Carolina, Virginia, and West Virginia, as well as the region mentioned above, covered about 65,000 square kilometers (≈ 25,097 square miles). From December 2 through December 12, 30 small magnitude aftershocks were recorded.
- **September 7, 1956**—Two tremors roughly 13 minutes apart were felt over a broad area in eastern Tennessee and adjoining parts of Kentucky, North Carolina, and Virginia. Chimneys were thrown down, plaster was knocked from walls, and windows were shattered. The total area covered approximately 21,500 square kilometers (≈ 8,300 square miles). (Modified Mercalli Intensity VI)
- **March 28, 1913**—In eastern Tennessee, a strong shock centered at Knoxville was felt over an area of 7,000 square kilometers (≈ 2,703 square miles). At a Modified Mercalli Intensity of VII, it was the most severe documented earthquake to strike East Tennessee.
- **November 28, 1844**—Tremor caused some bricks to fall from chimneys in Knoxville.

Thus, in over 167 years of recorded history in Knox County, there has been no significant structural damage from an earthquake. Some chimneys have fallen over, windows have been broken, things have fallen off shelves, pictures have fallen off of walls, but the earthquakes have caused more panic than actual damage. All of these

earthquakes occurred when there were no seismic design requirements, and the damages were all still minor.

The largest recorded earthquake from the New Madrid fault line was a series of four large earthquakes occurring in 1811 and 1812 at an approximate 300 mile distance from Knox County. These earthquakes were the strongest ever to occur in North America, estimated to be a XII on the Modified Mercalli Intensity Scale. Damage was reported as far away as Washington, DC. The shaking caused church bells in Boston to ring. Land rolled in visible waves. The Mississippi River was forced to change its course. Reelfoot Lake was formed. Other earthquakes in the zone of lesser magnitude occurred in 1843 and 1895. In 1843 the intensity VIII earthquake caused considerable shock to be felt in Knoxville, but no damage occurred. In 1895 the intensity VI earthquake caused shock to again be felt in Knoxville, but no damage was sustained.

Probability of Future Occurrences

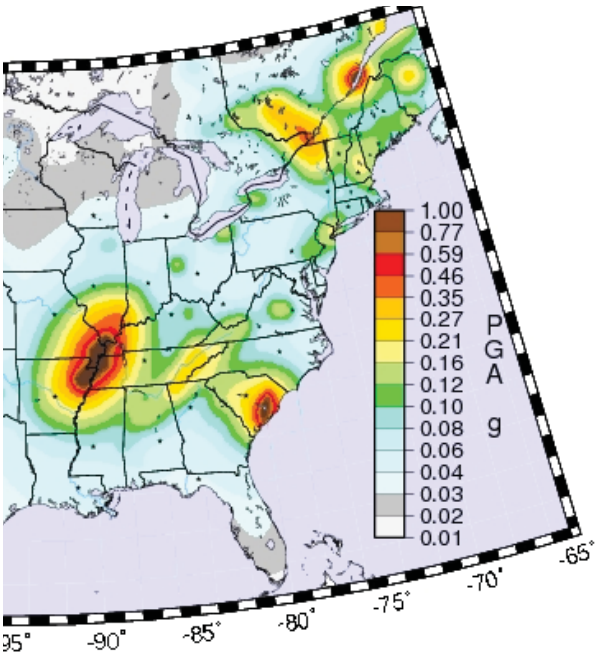
The East Tennessee Seismic Zone is an active fault, with events measuring between 2.0 and 3.0 on the Richter scale and large enough to be felt and noted annually.

Every 18 months the New Madrid Seismic Zone releases a shock of 4.0 or more, capable of local minor damage. Magnitudes of 5.0 or greater occur approximately once per decade, can cause significant damage and can be felt in several states. A damaging earthquake in the New Madrid area (6.0 or greater) occurs about every 80 years (the last one in 1895).

According to the U.S. Geological Survey, a more precise measurement of hazard for the planning area, a Peak Ground Acceleration (PGA) value was found for a two percent chance of being exceeded over 50 years. A PGA is a measure of the ground movements during an earthquake, and finding this value for a probability of two percent that this event will occur in 50 years is a commonly used earthquake measurement. Figure 3.17 indicates that there is a 27 percent probability of an earthquake exceeding peak acceleration of two percent gravity in the next 50 years in the Knox County planning area. Then in Figure 3.18 with U.S. Geological Survey data, it depicts a 10-12 percent probability of a 5.0 (Modified Mercalli Intensity Scale VI-VII) or greater earthquake occurring in the next 100 years.

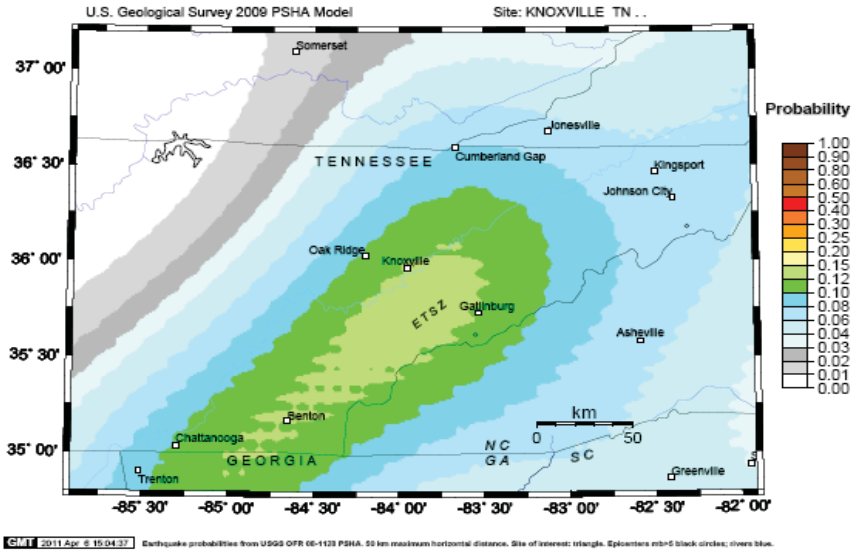
Thus the HMPC determined that the probability of earthquakes in the Knox County planning area is “likely” based on the historical occurrences. However, this probability rating is based on the fairly frequent, low magnitude quakes that have historically occurred, not a higher magnitude damaging earthquake.

Figure 3.17. **Peak Ground Acceleration—2 Percent Probability of Exceedence in 50 Years**



Source: U.S. Geological Survey, http://earthquake.usgs.gov/hazards/products/conterminous/2008/maps/

Figure 3.18. **Seismic Hazard Map—Probability of Magnitude 5.0 or Greater**



Source: U.S. Geological Survey, https://geohazards.usgs.gov/eqprob/2009/index.php

Magnitude

As previously discussed, in over 167 years of recorded history in Knox County, there has been no significant structural damage from an earthquake.

Scientists estimate with a probability of over 90 percent that a magnitude 6 to 7 earthquake will occur sometime in the next 50 years in the New Madrid zone. When this does occur, many more structures will be damaged than have been in the earthquakes out west because the structures around the New Madrid fault zone are not designed to withstand earthquakes, while the ones out west are. If a greater magnitude earthquake occurs, structural damage could exist in the Knox County planning area. Also, since the earthquake waves will travel underground for such a long distance, the period of the waves would become quite long (meaning the oscillations would occur at greater time intervals apart) because they would have a longer time to dissipate and would probably be between 1.5 and 2 seconds. For periods of this length, taller buildings are most affected and would definitely cause swaying of taller buildings. While an earthquake in the New Madrid fault zone with a magnitude greater than 7 is not likely to occur soon, it will probably occur one day.

Earthquake Hazard Summary

	Probability	Magnitude	Spatial Extent	Ranking
Planning Area Overall	3-Likely	1-Negligible	3- Extensive	2.3 (Medium)
Knox County	3-Likely	1-Negligible	3- Extensive	2.3 (Medium)
City of Knoxville	3-Likely	1-Negligible	3- Extensive	2.3 (Medium)
Town of Farragut	3-Likely	1-Negligible	3- Extensive	2.3 (Medium)

3.2.4 Expansive Soils

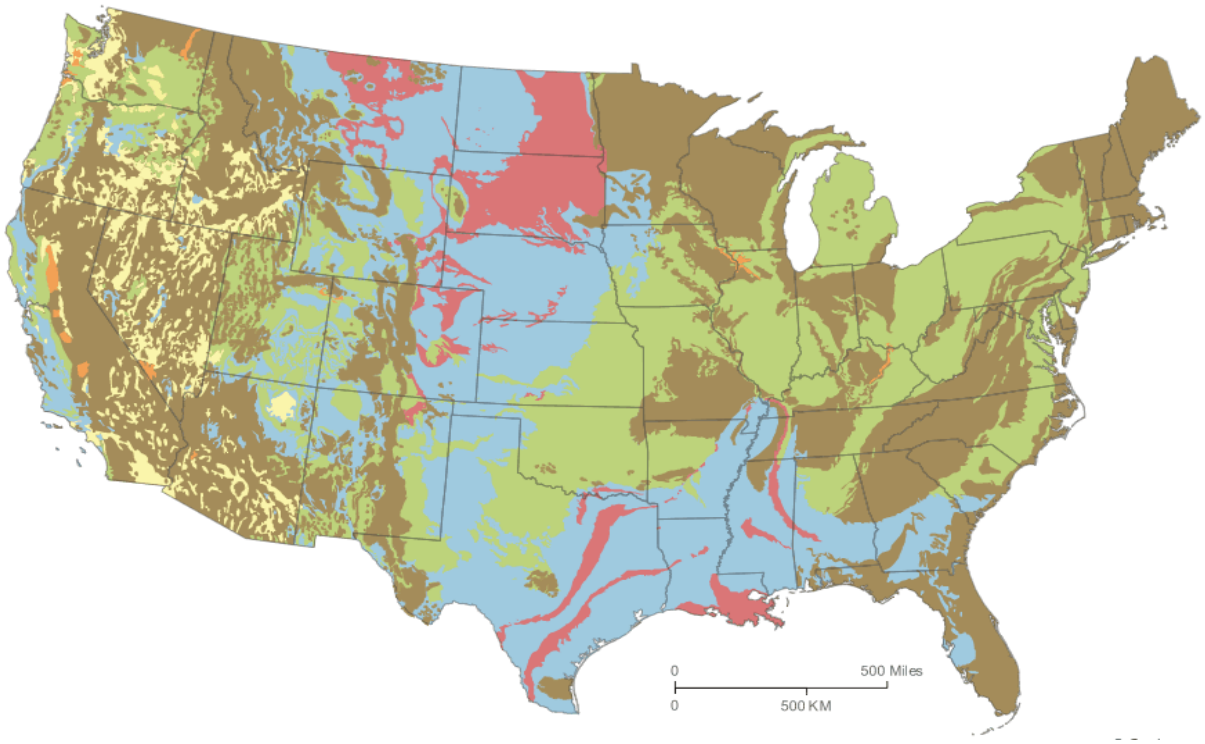
Description

Expansive soils are those that have a volume increase when they get wet and shrink when they dry. Expansive soils can cause damage to foundations, slabs, roads, sidewalks, pipelines and sometimes cause buildings and their components to crack. Expansive soils usually contain high amounts of clay. The subsurface conditions of East Tennessee primarily consist of limestone, dolomite, shale, and sandstone.

Geographic Location

Figure 3.19 shows a map of the United States depicting areas containing varying degrees of expansive soils. Knox County is located in the brown shaded area underlain by soils with little to no clays with swelling potential of soils.

Figure 3.19. **Expansive Soils Map**



Over 50 percent of these areas are underlain by soils with abundant clays of high swelling potential.

Less than 50 percent of these areas are underlain by soils with clays of high swelling potential.

Over 50 percent of these areas are underlain by soils with abundant clays of slight to moderate swelling potential.

Less than 50 percent of these areas are underlain by soils with abundant clays of slight to moderate swelling potential.

These areas are underlain by soils with little to no clays with swelling potential.

Data insufficient to indicate the clay content or the swelling potential of soils.

Source: "Swelling Clays Map of the Conterminous United States" by W. Olive, A. Chleborad, C. Frahme, J. Shlocker, R. Schneider and R. Schuster, published in 1989 as Map I-1940 in the USGS Miscellaneous Investigations Series.
http://geology.com/articles/soil/

Previous Occurrences

The effects of shrink-swell cycles in expansive soils are cumulative, and in most cases are associated with accelerated wear and tear and settling. The frequency of damage from expansive soils can be associated with the cycles of drought and heavy rainfall, which reflect changes in moisture content. There is no data regarding incidents of

damages resulting from expansive soils. These damages are largely isolated incidents and affected property owners make any necessary repairs.

Probability of Future Occurrence

Due to the limited amount of clay soils within Knox County's, significant damage from expansive soils is unlikely

Magnitude

The magnitude of any damages due to expansive soils is negligible.

Expansive Soils Hazard Summary

Impacts of expansive soils do not vary significantly within the planning area. Therefore, the hazard summary elements are rated the same for all jurisdictions, resulting in the same planning significance for this hazard.

	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	1-Unlikely	1-Negligible	1-Limited	1.00 (Low)
Knox County (unincorporated)	1-Unlikely	1-Negligible	1-Limited	1.00 (Low)
City of Knoxville	1-Unlikely	1-Negligible	1-Limited	1.00 (Low)
Town of Farragut	1-Unlikely	1-Negligible	1-Limited	1.00 (Low)

3.2.5 Extreme Temperatures

Description

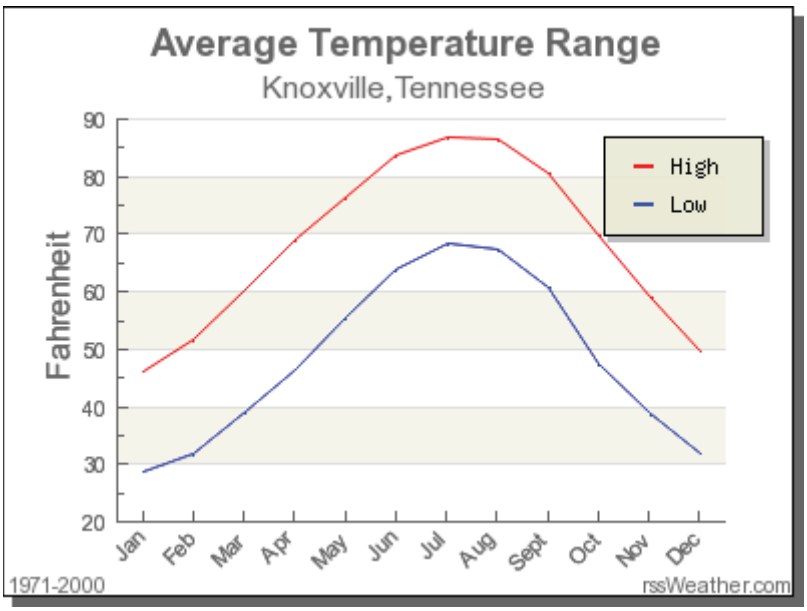
Extreme temperature events, both hot and cold, can have severe impacts on natural ecosystems, agriculture and other economic sectors, human health and mortality. All areas of Knox County have an equal chance of experiencing extreme temperatures in the summer or winter months. The average monthly temperatures for Knoxville, Tennessee are presented in Table 3.11 and Figure 3.20.

Table 3.11 Average Monthly Temperatures for Knoxville, Tennessee 1971-2000

Month	Low	High
Jan	28.9°F	46.3°F
Feb	31.8°F	51.7°F
Mar	39.1°F	60.3°F
Apr	46.6°F	69.0°F
May	55.6°F	76.3°F
Jun	63.9°F	83.6°F
Jul	68.5°F	86.9°F
Aug	67.3°F	86.4°F
Sept	60.8°F	80.7°F
Oct	47.7°F	69.9°F
Nov	38.9°F	59.0°F
Dec	31.9°F	49.8°F

http://www.rssweather.com/climate/Tennessee/Knoxville/

Figure 3.20. **Average Temperatures for Knoxville, Tennessee 1971-2000**



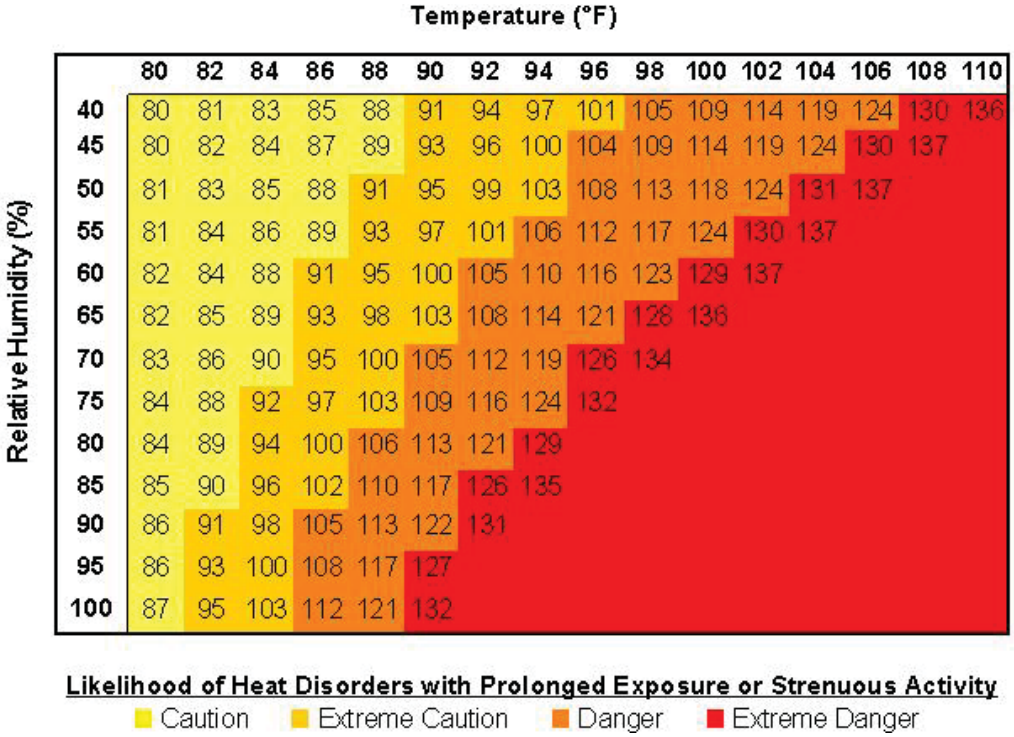
Source: http://www.rssweather.com/climate/Tennessee/Knoxville/

Extreme Heat

Temperatures that remain 10 degrees or more above the average high temperature for the region and last for several weeks are defined as extreme heat by FEMA. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when high atmospheric pressure traps damp air near the ground.

In an effort to alert the public to the hazards of prolonged heat and humidity episodes, the National Weather Service devised the "heat index". The heat index is an accurate measure of how hot it feels to an individual when the affects of humidity are added to high temperature. Figure 3.21 provides the heat index chart demonstrating how the heat index value is determined based on relative humidity. Table 3.12 that follows presents heat index values and their potential physical effects.

Figure 3.21. **Heat Index (HI) Chart**



Source: National Weather Service (NWS)

Note: Exposure to direct sun can increase Heat Index values by as much as 15°F. The shaded zone above 105°F corresponds to a HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

Table 3.12 Heat Index Values and Effects

Heat Index Values Combination of Heat and Humidity	Heat Index Effects
80 to 90 degrees F	Fatigue possible with prolonged exposure and/or physical activity.
90 to 105 degrees F	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and or physical activity.
105 to 130 degrees F	Sunstroke, heat cramps or heat exhaustion likely, and heatstroke possible with prolonged exposure and/or physical activity.
130 degrees and higher F	Heatstroke/sunstroke highly likely with continued exposure.

The National Weather Service will issue a *Heat Advisory* for Knox County when daytime heat indices are at or above 105°F and nighttime heat indices are at or above 80°F. An *Excessive Heat Warning* is issued when the heat index equals or exceeds 115°F for three hours or longer with a minimum heat index of at least 80°F during a 24-hour period. An excessive heat advisory is also issued when heat advisory conditions persist for at least 3 days. In either of these scenarios, the heat becomes dangerous for a large portion of the population. Those at greatest risk for heat-related illness include infants

and children up to four years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications. However, even young and healthy individuals are susceptible if they participate in strenuous physical activities during hot weather.

Extreme Cold

Extreme cold can cause hypothermia (an extreme lowering of the body's temperature), frostbite and death. Infants and the elderly are particularly at risk, but anyone can be affected. While there are no firm data on hypothermia (cold) death rates, it is estimated that 25,000 older adults die from hypothermia each year. The National Institute on Aging estimates that more than 2.5 million Americans are especially vulnerable to hypothermia, with the isolated elderly being most at risk. About 10 percent of people over the age of 65 have some kind of temperature-regulating defect, and 3-4 percent of all hospital patients over 65 are hypothermic. Also at risk are those without shelter or who are stranded, or who live in a home that is poorly insulated or without heat. Other impacts of extreme cold include asphyxiation (unconsciousness or death from a lack of oxygen) from toxic fumes from emergency heaters and household fires.

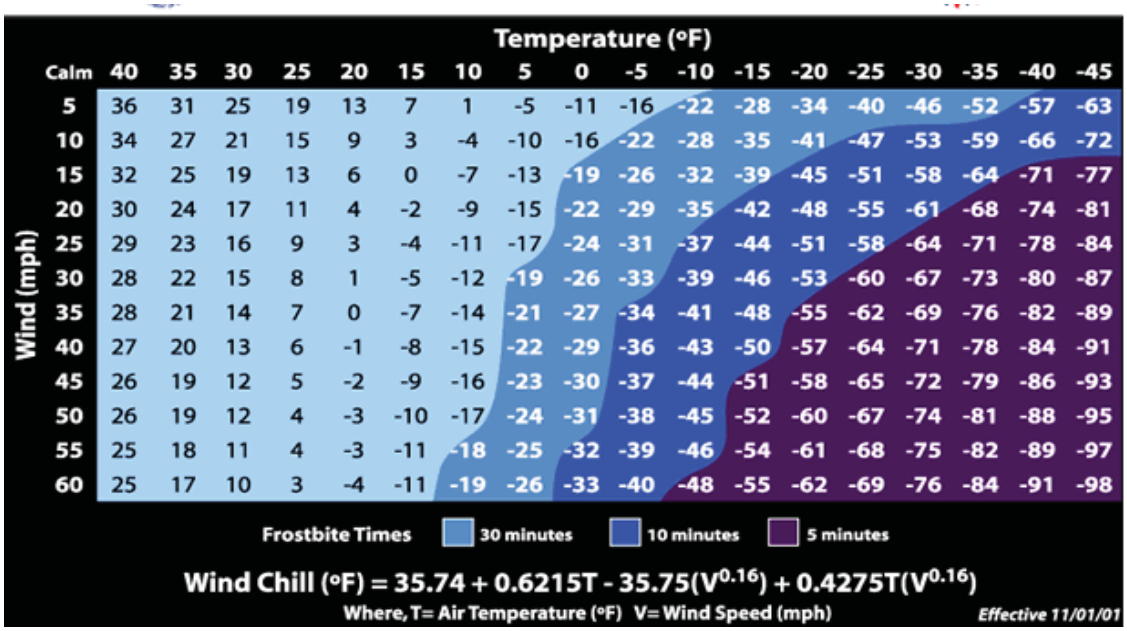
In 2001, NWS implemented an updated Wind Chill Temperature (WCT) index. This index was developed by the National Weather Service to describe the relative discomfort/danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Specifically, the new WCT index:

- Calculates wind speed at an average height of five feet (typical height of an adult human face) based on readings from the national standard height of 33 feet (typical height of an anemometer);
- Is based on a human face model;
- Incorporates modern heat transfer theory (heat loss from the body to its surroundings, during cold and breezy/windy days);
- Lowers the calm wind threshold to 3 mph;
- Uses a consistent standard for skin tissue resistance; and
- Assumes no impact from the sun (i.e., clear night sky).

Figure 3.22 shows the relationship of wind speed to apparent temperature and typical time periods for the onset of frostbite.

Figure 3.22. **Wind Chill Chart**



Source: National Weather Service

The National Weather Service will issue a Wind Chill Advisory for Knox County when wind-chill temperatures are expected to reach –4 °F to –20 °F.

Geographic Location

The entire planning area is subject to extreme temperatures and all participating jurisdictions are affected.

Previous Occurrences

Analysis of daily maximum temperatures recorded at the Knoxville McGhee Tyson Airport, station ID 404950 revealed that during the 61-year period from January 1, 1950 to April 7, 2011, 2,035 days had a high temperature exceeding 90 degrees Fahrenheit. This translates to just over 9 percent of the days during that time period. Thirty-three days in this time period had a high temperature of 100 degrees Fahrenheit or higher. The record high temperature at this station is 103 degrees Fahrenheit which occurred on three separate dates: September 5, 1954 and July 27 and 28, 1952. Table 3.13 summarizes the daily maximum temperatures from January 1, 1950 through April 7, 2011 that were 100 degrees Fahrenheit or higher.

Table 3.13 Daily Maximum Temperature 100 Degrees Fahrenheit or Higher, January 1, 1950-April 7, 2011, Knoxville McGhee Tyson Airport

Date	High Temperature (degrees Fahrenheit)
7/27/1952	103
7/28/1952	103
9/5/1954	103
6/24/1988	102
7/9/1988	102
8/23/2007	102
6/27/1952	101
7/23/1952	101
7/29/1952	101
7/14/1954	101
9/4/1954	101
9/6/1954	101
7/17/1980	101
8/21/1983	101
6/26/1988	101
7/8/1988	101
8/17/1988	101
8/18/1988	101
8/16/2007	101
9/1/1951	100
6/28/1952	100
6/30/1952	100
7/22/1952	100
6/27/1954	100
7/1/1954	100
9/7/1954	100
7/16/1980	100
8/10/1980	100
6/23/1988	100
7/8/1993	100
7/28/1993	100
8/16/1995	100
8/24/2007	100

Analysis of daily minimum temperatures recorded at the Knoxville McGhee Tyson Airport, station ID 404950 revealed that during the 61-year period from January 1, 1950 to April 7, 2011, 158 days had a low temperature of ten degrees Fahrenheit or less. Twenty-four days in this time period had a low temperature of zero or below. The record low temperature at this station occurred on January 21, 1985 with a temperature of minus 24 degrees Fahrenheit. Table 3.14 summarizes the daily minimum

temperatures from January 1, 1950 through April 7, 2011 that were zero degrees Fahrenheit or lower.

Table 3.14 Daily Minimum Temperature Zero Degrees Fahrenheit or Lower, January 1, 1950-April 7, 2011, Knoxville McGhee Tyson Airport

Date	Low Temperature (degrees Fahrenheit)
1/21/1985	-24
1/20/1985	-18
1/30/1966	-9
2/5/1996	-8
1/31/1966	-7
1/24/1963	-6
12/25/1983	-6
1/17/1982	-5
1/10/1970	-4
1/19/1994	-4
1/10/1982	-3
1/11/1982	-3
1/9/1970	-3
12/24/1983	-2
12/13/1962	-2
2/17/1958	-2
1/17/1977	-1
1/8/1970	-1
2/4/1970	0
1/18/1994	0
1/22/1970	0
1/28/1986	0
2/18/1958	0
12/23/1989	0

The following section summarizes two previous extreme temperature events in Knox County in the 16-year period from 1995 to 2010. Information on these events came from the National Climatic Data Center Of the historical events summarized; both were extreme heat events. NCDC did not report any extreme cold events.

- **June 27-28, 1998, Extreme Heat Event**—Two fatalities were reported in Knox County as a result of the extreme heat. The temperature reached 94 degrees Fahrenheit on the 27th and 95 degrees Fahrenheit on the 28th.
- **July 16, 1995, Extreme Heat Event**—There was one reported fatality as a result of this extreme heat event. The temperature reached 96 degrees Fahrenheit.

According to the USDA's Risk Management Agency, there were no insured crop losses in Knox County as a result of extreme heat from 2001 to 2010. However, in 2009, $12,987 in crop insurance for wheat was paid as a result of freeze conditions.

Probability of Future Occurrences

Based on historical maximum and minimum temperatures recorded at the Knoxville McGhee Tyson Airport from January 1, 1950 to April 7, 2011, temperatures above 90 degrees Fahrenheit occurred an average of 33 times each year while temperatures below 10 degrees Fahrenheit occurred an average of 2.6 times per year. This demonstrates that extreme heat events are more likely than extreme cold events. In general, at least one extreme temperature event per year is "highly likely".

Magnitude/Severity

Due to the potential for fatalities and the possibility for the loss of electric power due to increased strain on power generation and distribution for air conditioning, periods of extreme heat can have detrimental impacts in the planning area. In addition, accompanying drought may compound the problem exacerbating agricultural and economic losses. The impacts of extreme cold in the planning area have been primarily associated with agricultural losses. However, extreme cold can also cause injury such as frostbite or in extreme situations, death.

The primary concerns expressed by the planning committee for this hazard are the human health and safety issues. Although historically, there have been deaths associated with extreme temperature events, the HMPC determined that extenuating circumstances, not just the heat event, led to the deaths. Therefore, the magnitude/severity of this hazard was determined to be "limited".

Hazard Summary

Impacts of extreme temperatures do not vary significantly within the planning area. Therefore, the hazard summary elements are rated the same for all jurisdictions, resulting in the same planning significance for this hazard.

	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	4-Highly Likely	2-Limited	3-Extensive	3.1 (High)
Knox County (unincorporated)	4-Highly Likely	2-Limited	3-Extensive	3.1 (High)
City of Knoxville	4-Highly Likely	2-Limited	3-Extensive	3.1 (High)
Town of Farragut	4-Highly Likely	2-Limited	3-Extensive	3.1 (High)

3.2.6 Flood

Description

Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss. There are several different types of potential flood events in the planning area including riverine, flash, urban stormwater, and sinkhole flooding. Regardless of the type of flood, the cause can almost always be attributed to excessive rainfall, either in the flood area or upstream reach.

Riverine Flooding

Riverine flooding is defined as an event when a watercourse exceeds its “bank-full” capacity. Riverine floods result from precipitation over large areas. This type of flood occurs in river systems whose tributaries may drain large geographic areas and include many independent river basins. Riverine flooding generally occurs as a result of prolonged rainfall, or rainfall that is combined with soils already saturated from previous rain events. The duration of riverine floods may vary from a few hours to many days. Factors that directly affect the amount of flood runoff include precipitation, intensity and distribution, the amount of soil moisture, seasonal variation in vegetation, snow depth, and water-resistance of the surface areas due to urbanization.

The area adjacent to a river channel is its floodplain. In its common usage, “floodplain” most often refers to that area that is inundated by the 100-year flood, the flood that has a 1 percent chance in any given year of being equaled or exceeded. The 1 percent annual flood is the national standard to which communities regulate their floodplains through the National Flood Insurance Program.

Flash Flooding

The term "flash flood" describes localized floods of great volume and short duration. In contrast to riverine flooding, flash flooding usually results from a heavy rainfall on a relatively small drainage area. Precipitation of this sort usually occurs in the spring and summer. Another type of flooding in urban areas that is involved with flash flooding is urban flooding, this type of flooding occurs because urban land loses its ability to absorb rainfall as it is converted from fields or woodlands to roads, buildings, and parking lots. Urbanization increases runoff two to six times over what would occur on undeveloped terrain. During periods of urban flooding, streets can become swift moving rivers.

Sinkhole Flooding

Sinkhole flooding occurs when surface drainage goes underground into sinkholes, rather than continue to drain into tributaries and rivers that are part of the surface drainage basin. When floodwater drains into sinkholes, it is similar to a bathtub filling up when the faucet is turned on full force. Siphon holes suck out the water, similar to the drain in a bathtub. But, when there is too much water coming in at one time, or the

siphon holes become clogged, the sinkhole fills up and eventually becomes a lake. The resulting back-up of floodwaters can cause damages to property.

Geographic Location

Knox County includes part of the Tennessee, Holston, French Broad, and Clinch River watersheds. The lay of the land is prevailingly rolling and hilly, but some areas on the ridges underlain by the more resistant rock are very steep. The location of flood risk in the county differs depending on the type of flooding.

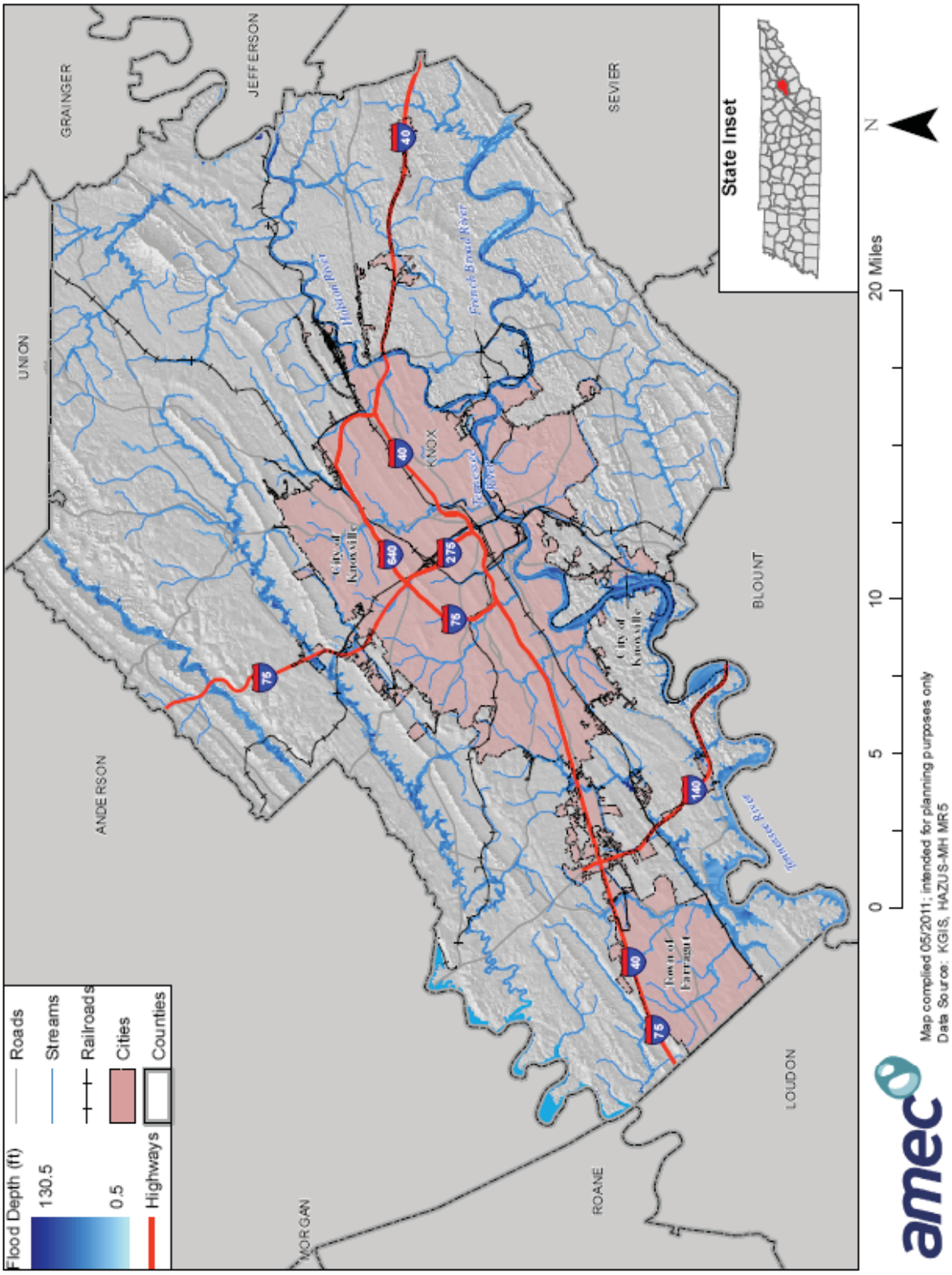
Riverine Flooding

The series of maps in Figure 3.23 to Figure 3.25 depict the areas of the planning area that are at risk to the 1 percent annually chance flood, also known as the 100-year floodplain. These are the areas that are at risk to riverine flooding. The maps were created using the 100 year Digital Flood Insurance Rate Map (DFIRM) flood boundary, and 5 foot Digital Elevation Model (DEM).

Knox County

The natural surface drainage system is well developed. The larger streams flowing in the valleys form the main stems of a trellis system. In many places, streams flow through gaps in the ridges. In those parts of the county overlaying dolomitic limestone, a karst-like topography prevails. Many of the small drains lead to sinkholes, where runoff water enters subterranean channels. Part of the runoff water, however, proceeds through a partially formed dendritic surface system to permanent surface streams in the shale valleys. Poorly drained areas are confined to small tracts along some of the drainageways and on floors of some of the sinkholes

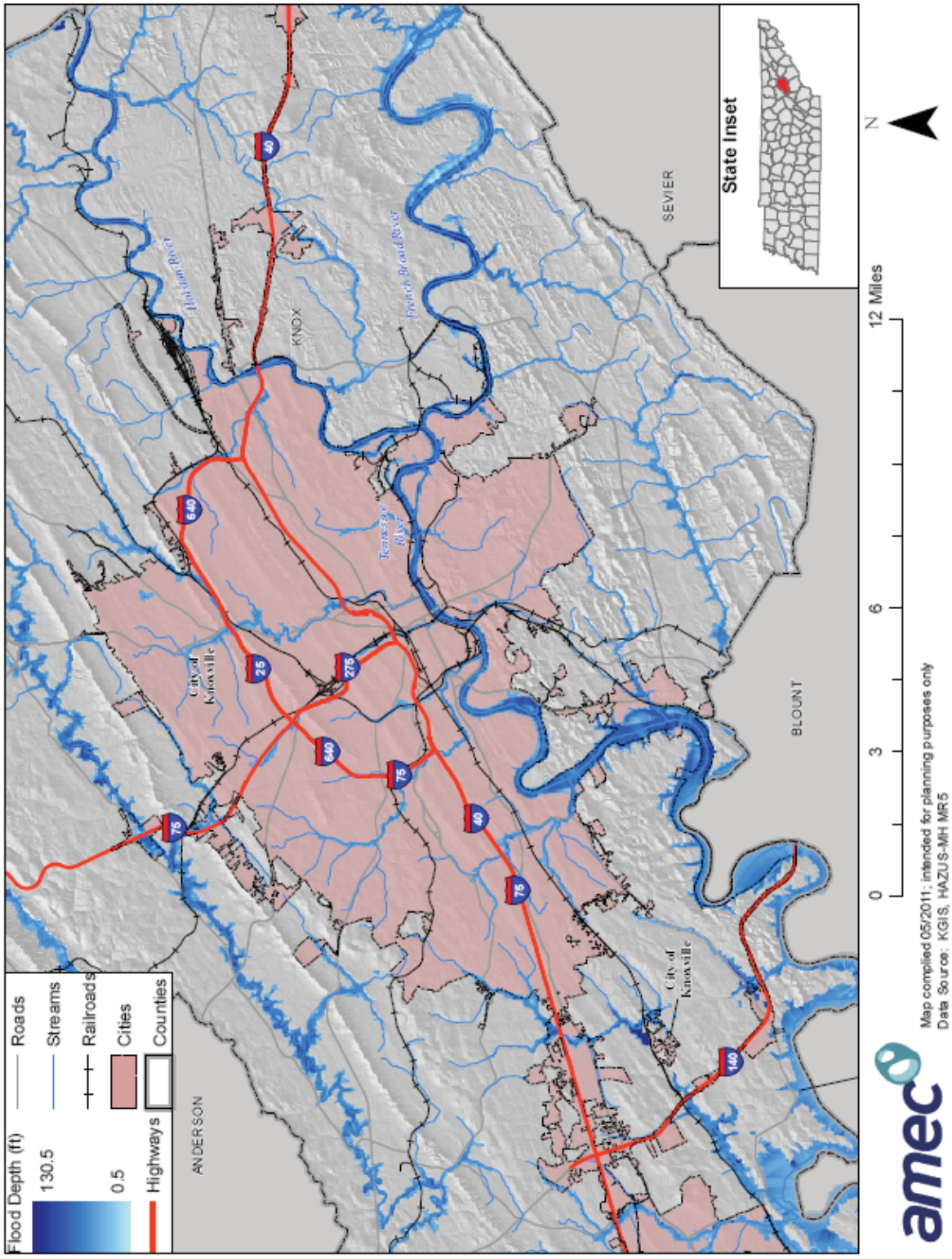
Figure 3.23. **Knox County HAZUS/DFIRM 100-Year Floodplain**



City of Knoxville

The City of Knoxville is located at the junction of the Holston River and the French Broad River, and the head of the Tennessee River, and it extends downstream some 12 miles on the Tennessee River.

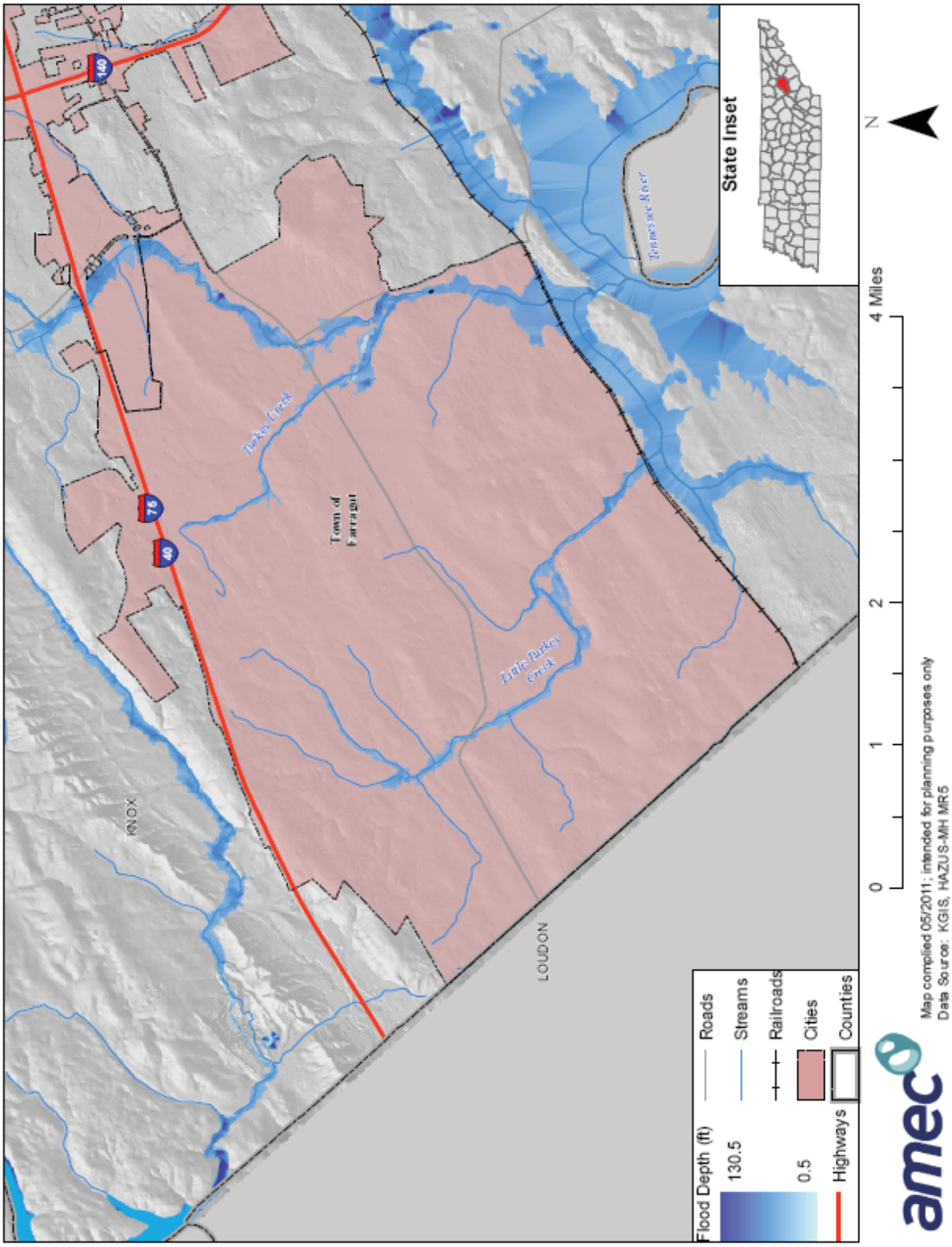
Figure 3.24. **City of Knoxville HAZUS/DIRM 100-Year Floodplain**



Town of Farragut

The principle flooding sources affecting the Town of Farragut are the Little Turkey Creek, North Fork Turkey Creek, Tennessee River, and Turkey Creek. Although the Tennessee River is not in the corporate limits of Farragut, it affects the community through backwater up Turkey Creek and Little Turkey Creek.

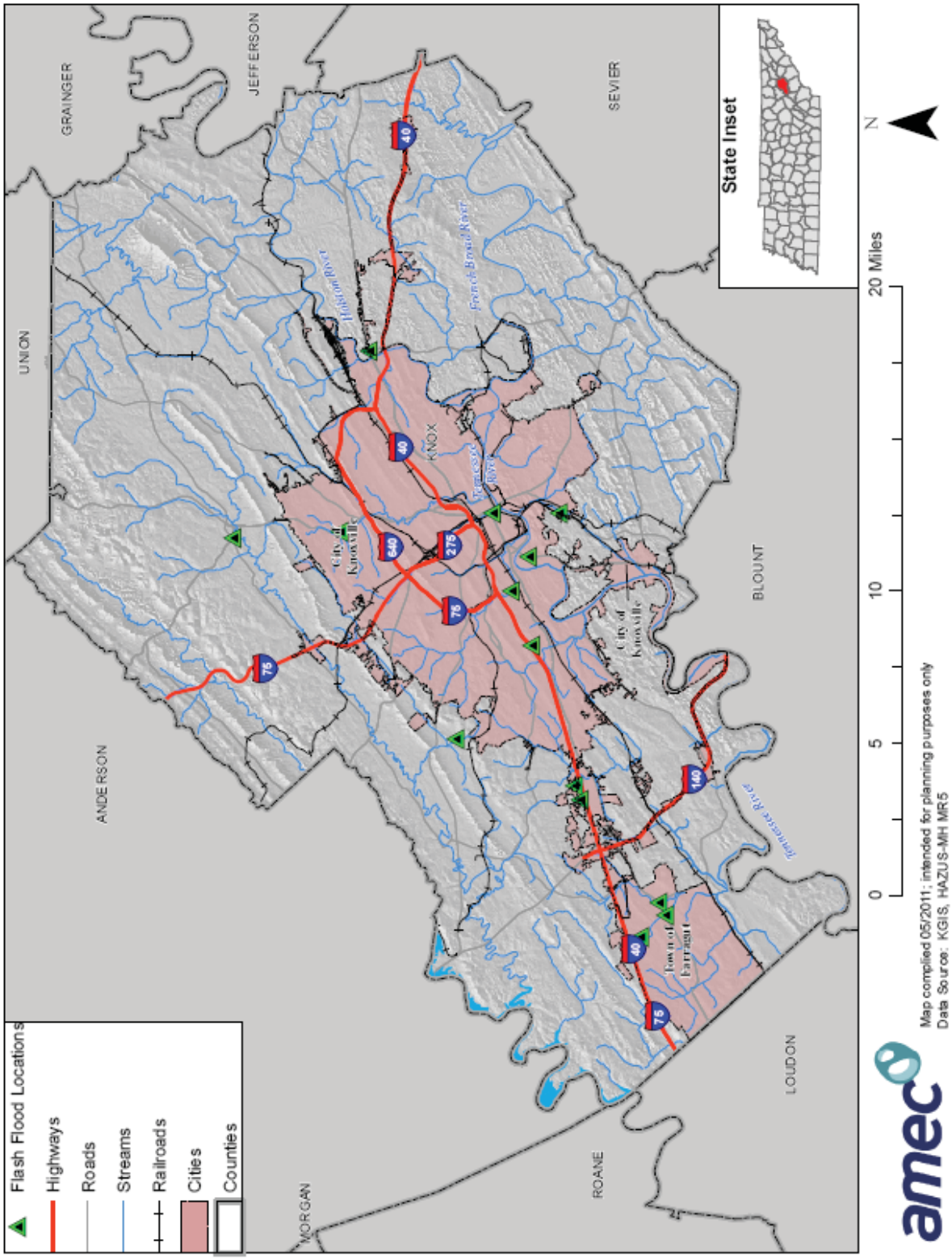
Figure 3.25. **Town of Farragut HAZUS/DFIRM 100-Year Floodplain**



Flash Flooding

The type of flash flooding that normally occurs in the planning area is when intense rainfall occurs in the drainage basin and urban areas and cannot be carried away by natural or urban drainage systems as fast as it is falling. The map in Figure 3.26 depicts locations within the planning area (identified with green triangle) that have historically been impacted by flash flooding. However, it should be noted that flash floods can occur throughout the planning area if intense rainfall occurs.

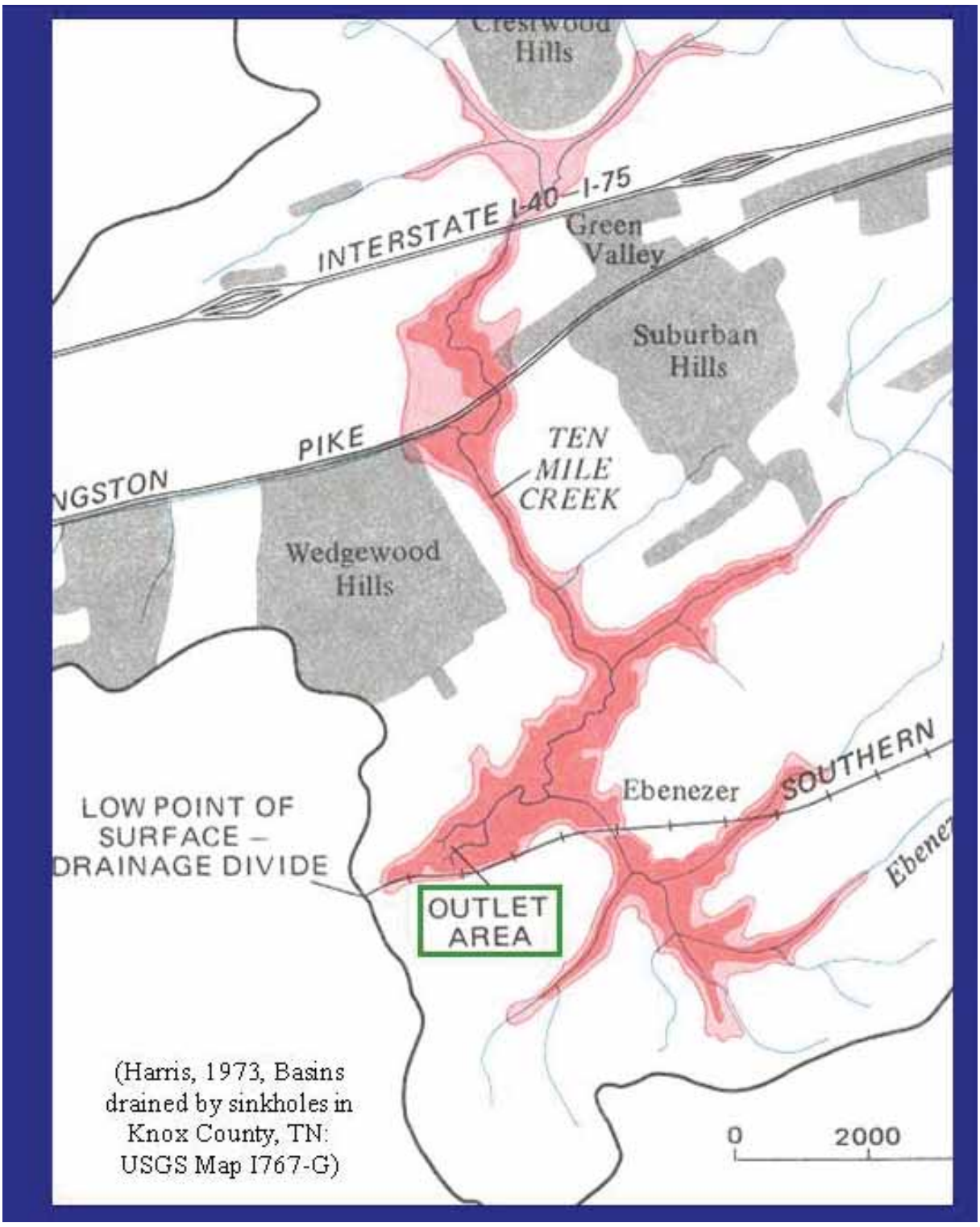
Figure 3.26. **Flash Flood Areas in Knox County**

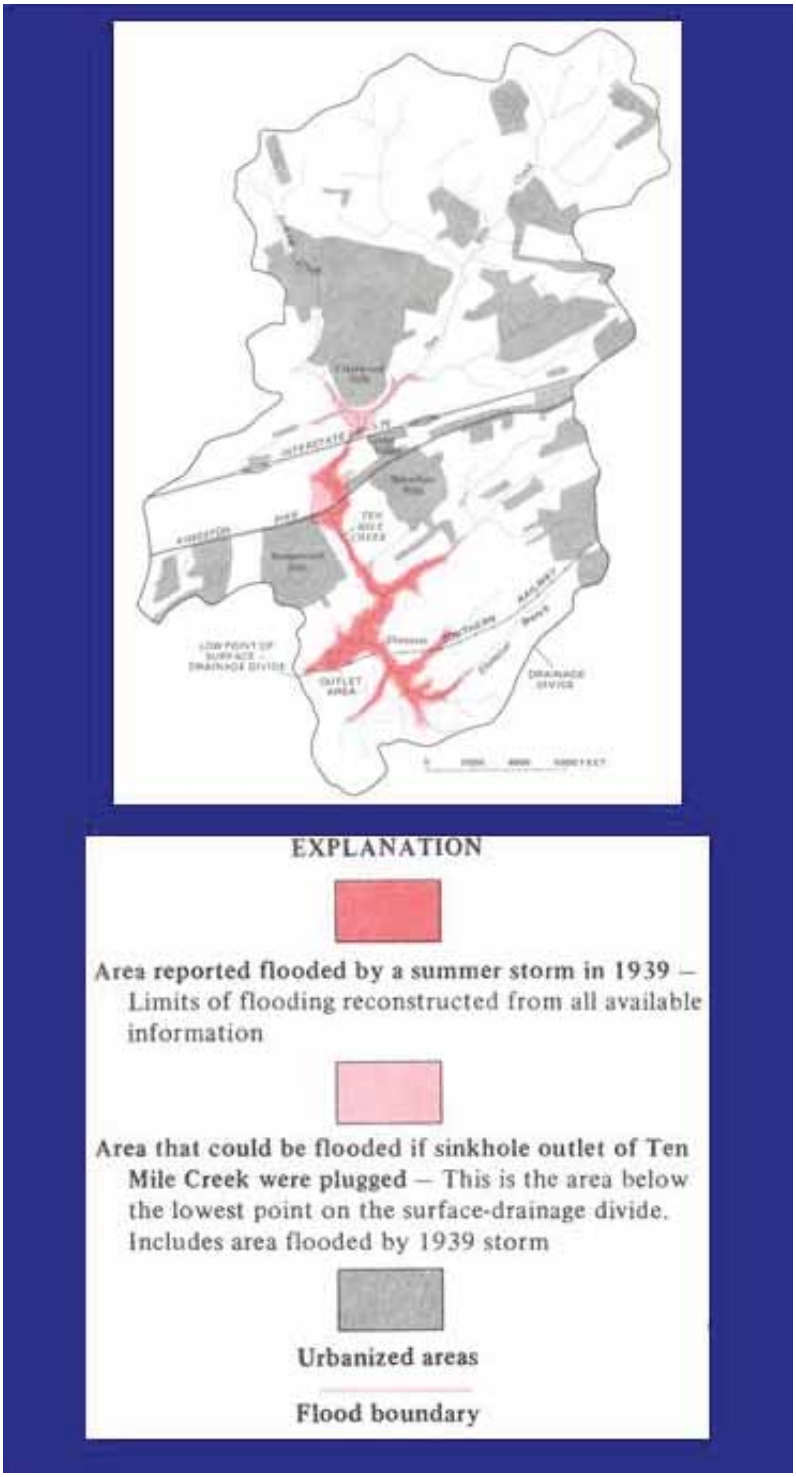


Sinkhole Flooding

The Ten Mile Creek Drainage Basin is a specific basin within the planning area that has been identified as prone to sinkhole flooding. The map in Figure 3.27 shows locations within the Ten Mile Creek Drainage Basin that could be flooded if the outlet is plugged.

Figure 3.27. **Ten Mile Creek Sinkhole Flooding**





Source: Tennessee Department of Environment and Conservation-Division of Geology, Harris 1973, Basins Drained by Sinkholes in Knox County, TN, USGS Map 1-767-G

National Flood Insurance Program and Repetitive Flood Loss Properties

Table 3.15 provides details on participation in the National Flood Insurance Program as well as flood insurance policies and claims.

Table 3.15 Community Participation in the National Flood Insurance Program in Knox County

Jurisdiction	Status/Date	CRS Participant (Y/N)/ Class	Effective FIRM Date	Policies in Force	Insurance in Force ($)	Number Paid Losses	Total Losses Paid($)
Knox County	Participating Regular-7/23/1971	Y Class 9	8/5/2013	533	131,507,400	110	955,831
City of Knoxville	Participating Regular-4/30/1971	Y Class 8	8/5/2013	289	57,508,700	173	2,047,140.31
Town of Farragut	Participating Regular-7/23/1971	N	8/5/2013	53	14,854,500	5	68,818

Repetitive Loss Properties

There are a total of 19 repetitive loss (RL) properties in the unincorporated areas of Knox County. Of those, one is a post-FIRM Special Flood Hazard Area building. One building has had four or more losses, none have had two to three losses, resulting in one target repetitive loss building for mitigation.

Knox County

Table 3.16 Repetitive Loss Properties and Statistics, Knox County (unincorporated)

	AE, A1-30, AO, AH, A	VE, V1-30, V	B, C, X	TOTAL
RL Buildings (Total)	10	0	9	19
RL Buildings (Insured)	5	0	6	11
RL Losses (Total)	23	0	26	49
RL Losses (Insured)	11	0		27
RL Payments (Total)	$207,463.59	$.00	$423,233.79	$630,697.38
Building	$146,198.81	$.00	$362,556.57	$508,755.38
Contents	$61,264.78	$.00	$60,677.22	$121,942.00
RL Payments (Insured)	$80,654.05	$.00	$250,380.85	$331,034.90
Building	$58,939.63	$.00	$225,497.05	$284,436.68
Contents	$21,714.42	$.00	$24,883.80	$46,598.22

Post - FIRM SFHA RL Buildings: 1
Insured Buildings with 4 or More Losses: 1
Insured Buildings with 2-3 Losses > Building Value: 0
Total Target RL Buildings: 1

City of Knoxville

There are a total of 24 repetitive loss (RL) properties in the City of Knoxville. Of those, one is a post-FIRM Special Flood Hazard Area building. One building has had four or more losses; none have had two to three losses, resulting in one target repetitive loss building for mitigation.

Table 3.17 Repetitive Loss Properties and Statistics, City of Knoxville

	AE, A1-30, AO, AH, A	VE, V1-30, V	B, C, X	TOTAL
RL Buildings (Total)	17	0	7	24
RL Buildings (Insured)	7	0	1	8
RL Losses (Total)	47	0	19	66
RL Losses (Insured)	17	0		21
RL Payments (Total)	$432,607.74	$.00	$644,120.63	$1,076,728.37
Building	$407,682.46	$.00	$394,487.77	$802,170.23
Contents	$24,925.28	$.00	$249,632.86	$274,558.14
RL Payments (Insured)	$172,507.36	$.00	$471,386.91	$643,894.27
Building	$164,142.36	$.00	$328,252.75	$492,395.11
Contents	$8,365.00	$.00	$143,134.16	$151,499.16

Post - FIRM SFHA RL Buildings: 1
Insured Buildings with 4 or More Losses: 1
Insured Buildings with 2-3 Losses > Building Value: 0
Total Target RL Buildings: 1

Town of Farragut

There is one repetitive loss (RL) property in the Town of Farragut. None are post-FIRM Special Flood Hazard Area buildings and no buildings have had two or more losses. Therefore, there are no target repetitive loss buildings for mitigation.

Table 3.18 Repetitive Loss Properties and Statistics, Town of Farragut

	AE, A1-30, AO, AH, A	VE, V1-30, V	B, C, X	TOTAL
RL Buildings (Total)	0	0	1	1
RL Buildings (Insured)	0	0	1	1
RL Losses (Total)	0	0	2	2
RL Losses (Insured)	0	0		2
RL Payments (Total)	$.00	$.00	$15,910.62	$15,910.62
Building	$.00	$.00	$15,700.22	$15,700.22
Contents	$.00	$.00	$210.40	$210.40
RL Payments (Insured)	$.00	$.00	$15,910.62	$15,910.62
Building	$.00	$.00	$15,700.22	$15,700.22
Contents	$.00	$.00	$210.40	$210.4

Post - FIRM SFHA RL Buildings: 0
Insured Buildings with 4 or More Losses: 0
Insured Buildings with 2-3 Losses > Building Value: 0
Total Target RL Buildings: 0

Previous Occurrences

The flood events in the NCDC database were reviewed. Considering the dates and times, as well as narrative descriptions, it was determined that there were 27 separate reported flood events in Knox County between 1993 and 2010. Of the 27 events, 6 were reported as river floods. The remaining 21 were flash floods. The NCDC database does not categorize sinkhole flooding. However, the narrative descriptions indicate sinkhole flooding, where applicable. In all, these events resulted in an estimated $26 Million in property damages.

In addition, Knox County has been included in five Presidential disaster declarations that included flooding between 1953 and 2011. For three of those declarations (DRs 1464, 1331, and 424), however, the damages in Knox County, and its inclusion in the declarations was primarily for tornado events. These events will be discussed in Section 3.2.10. Additional Local accounts are also provided Historical accounts of flooding events are recorded below. Sources are the NCDC database, FEMA, local news, and HMPC accounts.

- **April 27, 2011, Flash Flooding**—Severe storms including intense rain, hail and tornadoes swept over east Tennessee, including Knox County. Several intersections were flooded.
- **February 28, 2011, Flash Flooding**—As a result of this event, police closed Interstate 640. North Knoxville & Fountain City—shopping centers along Broadway flooded up to car windows.

Figure 3.28. **February 28, 2011 Flash Flooding**

Source: http://www.wate.com/Global/story.asp?S=14155594

- **September 26, 2009, Flash Flooding**—Flooding occurred on a few streets in southeast Knoxville. Several inches to nearly a foot of water was reported over the streets, with several areas briefly impassable due to the flooding.
- **September 23, 2006, Flash Flooding**—Flooding from stationary thunderstorms caused flooding of streets in downtown Knoxville and in the west end of the county. In the Cedar Bluff area, floodwaters covered streets and entered some basements.
- **August 4, 2006, Flash Flooding**—Thunderstorm rains produced four feet of water at the intersection of Cumberland and Poplar Streets in Knoxville.
- **July 6, 2005, Flash Flooding**—Three feet of water on Interstate 40 at Papermill Road.
- **June 17, 2004, Flash Flooding**—"Shoulder deep" water covered the parking of an apartment complex in Bearden, covering some vehicles and invading several units. Also, water filled the parking of a popular restaurant in Bearden, completely submerging several vehicles. Damage was estimated at $300,000.
- **June 14, 2004, Flash Flooding**—Car submerged on Kingston Pike as flash flood waters invaded area. Damage estimated at $10,000.

- **May 5, 2003, Flash Flooding**—Kingston Pike and Gleason Road flooded and closed. Some sinkholes filled to overflowing, minor mudslides. Damage estimated at $2,800,000.
- **April 10, 2003, Flood**—Seven day rainfall totals (4th through the 10th) of three to five inches were reported across central east Tennessee and northeast Tennessee, with one to three inches occurring on the 10th. Several secondary roads across the area were flooded with several rivers experiencing some minor flooding including the Clinch, French Broad, Holston, Pigeon and Powell rivers.
- **February 21, 2003, Flood**—With the ground already saturated from the previous week's rainfall, three day rainfall totals of one to three inches created some flooding of streams and rivers as well as several mudslides across east Tennessee. Rivers which rose above their flood stages included the South Chickamauga, Clinch, Powell, Holston, Pigeon, French Broad and Sequatchie rivers.
- **February 14-16, 2003, Flood**—Seventy roads reported to be flooded with some closed. One injury reported in an apartment complex which was destroyed by a mudslide. Four day rainfall totals of two to eight inches fell across east Tennessee, with the highest amounts occurring across the Cumberland Plateau and adjacent valleys areas. This rainfall combined with a melting snowpack (reports of up to a foot in the higher elevations) to produce widespread flooding of rivers and streams with numerous mudslides also reported (one notable mudslide pushed an apartment complex off its foundation in Knox County). The Powell, Clinch and Holston rivers measured the most significant rises with Claiborne, Rhea and Knox counties reporting the most significant damage.
- **March 17, 2002, Flood**—Widespread flooding occurred across most of East Tennessee with the hardest hit counties in central East Tennessee including Bledsoe, Meigs, Roane, Rhea, Loudon, Blount, Knox, and Sevier Counties. Rainfall totals between five and eight inches were reported in 36 hours. Numerous major rivers flooded including the Clinch, Powell, Sequatchie, and Pigeon Rivers. Total damage estimates were calculated to be over 5 million dollars.
- **January 23, 2002, Flood**—Prolonged heavy rain throughout the day resulted in numerous road closings across much of central East Tennessee.
- **August 30, 2001, Urban Flood**—Many roads in the Cedar Bluff, Cross Park and Bridgewater areas were flooded and closed. Several persons had to be evacuated from cars.
- **April 4, 2000**, Flash Flood
- **July 11, 1999, Floo**d—Widespread showers and thunderstorms with heavy rain caused flooding problems throughout much of East Tennessee. In Knox County, many cars were stranded in flooded underpasses.
- **June 1-2, 1998, Flash Flooding**—Apartment building evacuated due to flooding at Knox Lane and Fair Drive. Alcoa Highway near the Navy/Marine Corps Reserve Center was impassable due to water across the road.

- **May 21, 1998, Flash Flooding**—junction of John Sevier and Asheville Highway was flooded up to car bumpers.
- **May 7, 1998, Urban Flood**—Flooding on Emory Road and Norris Freeway.
- **April 17-18, 1998, Flash Flooding (FEMA-1215-DR)**—Long-lived heavy rain event caused evacuations of apartments throughout the county. Numerous roads underwater and impassable throughout county. Road near West Town Mall flooded. 2 inches of rain per hour near Karns.
- **July 1, 1997, Flash Flood**—Flash flooding in the Shipetown area resulted in a tractor trailer and several cars stalling in flooding from Flat Creek along Mine Road. Several individuals including the tractor trailer driver, had to be rescued from their vehicles.
- **April 21, 1997, Flash Flood**—Heavy rain over several hours resulted in flash flooding. Parts of I-40 were underwater
- **May 9, 1995, Flash Flooding**—Several roads were closed due to flooding.
- **April 15, 1994, Flash Flooding/Sinkhole Flooding**—Locally heavy rainfall produced flash flooding across the southeast corner of Tennessee. Numerous roads were closed because of the flash flooding. Some rock and mud slides occurred as well. An apartment complex was flooded in Knox County. Damages were estimated at $50,000.
- **March 27, 1994, Flash Flooding/Sinkhole Flooding**
- **February 10-11, 1994, Flash Flooding/Sinkhole Flooding**
- **December 4, 1993, Flash Flooding**—several roads were flooded
- **August 20, 1993, Flash Flooding**—Nearly 2.00 inches of rain flooded a few roads and underpasses
- **July 31, 1982, Flood**—this flood on upper First Creek exceeded all experienced previously in its urban history. Intense rainfall over a 13-hour period produced several rain gage totals in the Fountain City area that exceeded seven inches. Floods on upper First Creek and to a much lesser extent other Knoxville streams resulted in damages estimated by the Knoxville News-Sentinal at $1.2 to $2 million. -mentioned in FIS. Fourth Creek also flooded as a result of this event causing extensive inundation of roads and parking lots.
- **March 21, 1973, Flood (FEMA-366-DR)**
- **1971, Flood**—this flood event included sinkhole flooding in the ten-mile creek drainage basin. A 16-square mile area drains into a two-mile long sinkhole that is about 50 feet deep. The sinkhole filled up during the flood event and backed up into the drainage basin causing flooding. Among other damages, waters that backed up, went over a dike built around a pumping station, causing an estimated $150,000 in damages and putting the station out of commission for an extended period.
- **March 27, 1963, Flood (FEMA151-DR)**—This federal disaster declaration was made following severe storms and heavy rains caused urban flooding in the planning area.

According to the USDA's Risk Management Agency, insured crop losses in Knox County as a result of flood conditions and excessive moisture from 2001 to 2010 totaled $106,565. According to the 2010 Tennessee Crop Insurance Profile, 82 percent of insurable crops were insured. Historical crop insurance claims as a result of flooding are detailed in Table 3.19.

Table 3.19 Claims Paid in Knox County for Crop Loss as a Result of Flood and Excessive Moisture (2001-2010)

Year	Crop	Hazard	Claims Paid
2010	SOYBEANS	Excess Moisture/Precip/Rain	$6,249
2009	WHEAT	Excess Moisture/Precip/Rain	$19,480
2009	BURLEY TOBACCO	Excess Moisture/Precip/Rain	$1,249
2009	All Other Crops	Excess Moisture/Precip/Rain	$147
2004	BURLEY TOBACCO	Excess Moisture/Precip/Rain	$10,130
2003	BURLEY TOBACCO	Excess Moisture/Precip/Rain	$250
2001	FRESH MARKET TOMATOES	Excess Moisture/Precip/Rain	$69,060
Total			**$106,565**

Source: USDA Risk Management Agency, 2011

Probability of Future Occurrences

Based on data from FEMA, the NCDC database and local accounts, from 1973 to 2008, there were 19 records of flood or flash flood events over a 35 year period. The average number of flood and flash flood events calculates to .54 per year. Therefore, the probability of future occurrences for flooding is "highly likely".

Magnitude/Severity

The floodplain extends into some populated areas of Knox County indicating that some property damage from riverine flooding will occur during larger events. The most frequent type of flooding and damages are as a result of the frequent flash flood events. These are especially problematic in the urban areas where development increases the rate of water flow and decreases the ability for water to be absorbed into the ground. The HMPC determined the magnitude to be "limited".

Flood Hazard Summary

Frequency, magnitude, and spatial extent of flooding are in general, less of a concern in Farragut than in the unincorporated portions of the county and the City of Knoxville. Although Farragut does have some riverine and flash flooding, it is to a lesser extent. This is further evidenced by just one repetitive loss property in Farragut compared to 17 in the City of Knoxville and 10 in the unincorporated county. In addition, as discussed later in this document, the estimated number of people displaced by flooding as well as financial loss is expected to be less for a riverine flood in Farragut than the other jurisdictions.

	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	4-Highly Likely	2-Limited	3-Extensive	3.1 (High)
Knox County (unincorporated)	4-Highly Likely	2-Limited	3-Extensive	3.1 (High)
City of Knoxville	4-Highly Likely	2-Limited	3-Extensive	3.1 (High)
Town of Farragut	3-Likely	1-Negligible	1-Limited	1.9 (Low)

3.2.7 Land Subsidence/Sinkholes

Description

Certain areas underlain by limestone and dolomite in Knox County contain many circular to elongate surface depressions (sinkholes), caves, springs, and disappearing streams generally arranged in a systematic fashion. These features result from the solution of the limestone and dolomite by surface and groundwater. The type of landscape produced is so common worldwide in areas underlain by these rocks that a special term, karst, is used to describe it. Karst is a common underground condition in East Tennessee resulting in ground fissures, sinkholes, underground streams, and caverns. Most of Tennessee's geography contains some karst, but East Tennessee is one of the areas in Tennessee containing more karst than others. East Tennessee also suffers more sinkholes than other parts of the state. Common problems associated with the karst areas include subsidence, collapse, temporary or permanent flooding in sinkholes and contamination of groundwater resources. The flooding issues associated with the presence of sinkholes are discussed in more detail in section 3.2.6, Flooding.

Development of a karst landscape is dependent on the fact that limestone and dolomite slowly dissolved in water charged with weak acid. Groundwater with naturally produced weak organic acid causes the solution and removal of these minerals, developing pits, underground channelways, and caverns into which the land surface slowly settles, and into which surface water flows. Sinkholes may result either from solution of dolomite or limestone by groundwater at the surface or by collapse of the roof of an underground cavern. This process results in disappearing or nonexistent surface drainage.

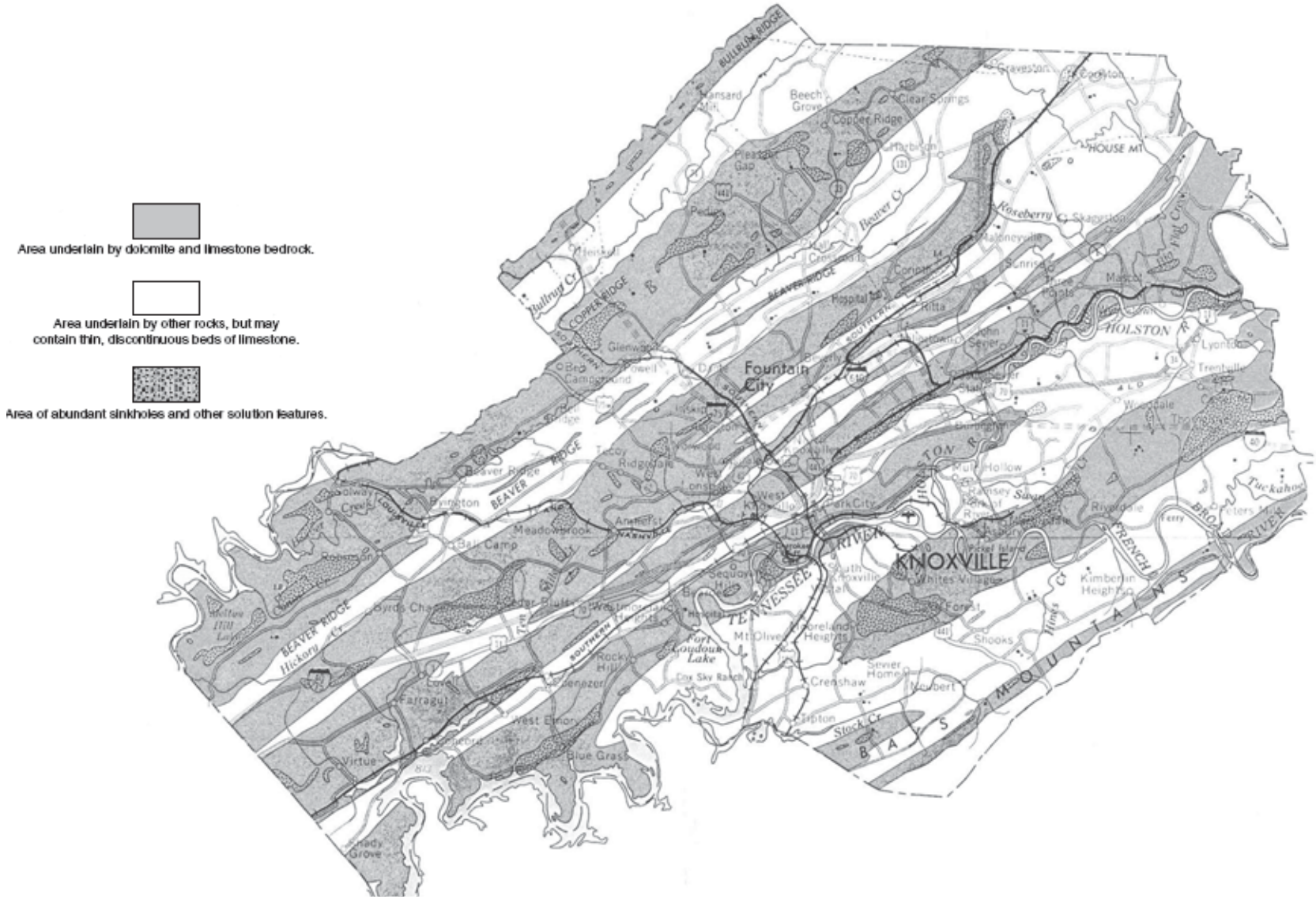
Shapes of sinkholes in the county are variable, ranging from a few funnel-like steep-sided holes to abundant relatively broad, nearly flat-bottomed basins. In general, funnel-like sinks are less than a few hundred feet in diameter and may be as much as 100 feet deep. Basin-like sinks are a few hundred to several thousand feet in diameter and a few feet to at least 80 feet deep.

Geographic Location

According to a 1995 Investigation of Sinkhole Flooding Problems in Knoxville, Tennessee by Albert E. Ogden of the Department of Earth Sciences, Clemson, University, South Carolina, approximately 15 percent of the City of Knoxville is built around or in sinkholes. All areas underlain by limestone and dolomite in Knox County

contain at least some solution features. Those areas where solution has been intense enough to develop sinkhole high density are outlined on the map in 0.

Figure 3.29. **Areas with Abundant Sinkholes in Knox County,**



Tenne Source: Map from: Harris, L.D., 1973, Areas with abundant sinkholes in Knox County, Tennessee: United States Geological Survey Map I-767F

Previous Occurrences

- **April 27, 2011—**Fox Lonas Road was closed between Crest Forrest and Roderick due to a large sinkhole that developed after an intense rainfall event. The large cavern developed underneath the roadway and had to be excavated and backfilled before the road could be reopened.
- **May 2007**—A sinkhole developed on the south-bound side of Pellissippi Parkway just south of Oak Ridge Highway. The hole was initially filled with 720 tons of rock and 40 cubic yards of concrete. Temporary repairs resulted in repaving the section twice before permanent repairs could be made later that summer.
- **May 2005**—A sinkhole collapse occurred adjacent to Chapman Highway.

Figure 3.30. **Sinkhole Collapse Adjacent to Chapman Highway, May 2005**

Source: Tennessee Department of Environment and Conservation-Division of Geology

- **2004**—A sinkhole caused a collapse in a parking lot on Papermill Road.

Figure 3.31. **Sinkhole Collapse in Papermill Road Parking Lot, 2004**

Source: Tennessee Department of Environment and Conservation-Division of Geology

- **October 1956**—A sinkhole developed during construction of the First Creek sewer. The sinkhole developed just south of East Vine Avenue near Central Street

Probability of Future Occurrences

During the period from 2000-2009, there were four documented damaging sinkholes. This period of history results in a 40 percent annual probability of damaging sinkholes in the planning area. Therefore, the probability of this hazard is “highly likely”

Magnitude/Severity

In general, when sinkholes occur, impacts are limited to a fairly small area and the magnitude of damages is “limited”.

Land Subsidence/Sinkholes Hazard Summary

Compared to the unincorporated county and the City of Knoxville, the Town of Farragut has had fewer reported damaging sinkholes. In addition, as demonstrated in the map in 0, the Town of Farragut has less known areas of abundant sinkholes. Therefore, the ratings for frequency and spatial extent are lower for the Town of Farragut than the unincorporated county and the City of Knoxville.

	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	4-Highly Likely	2-Limited	2-Significant	2.9 (Medium)
Knox County	4-Highly Likely	2-Limited	2-Significant	2.9 (Medium)
City of Knoxville	4-Highly Likely	2-Limited	2-Significant	2.9 (Medium)
Town of Farragut	3-Likely	2-LImited	1-Limited	2.25 (Medium)

3.2.8 Landslide

Description

Landslides are the downward and outward movement of earth materials on a slope. Landslides generally move by the falling, sliding, or flowing of rock and (or) soil, or by a combination of these and other less common types of movement. Causes include earthquakes, reservoir draw-downs, heavy precipitation, and floods.

Landslides constitute a major geologic hazard because they are widespread, occur in all 50 states and U.S. territories, and cause $1-2 billion in damages and more than 25 fatalities on average each year. Expansion of urban and recreational developments into hillside areas leads to more people that are threatened by landslides each year. Landslides commonly occur in connection with other major natural disasters such as earthquakes, volcanoes, wildfires, and floods.

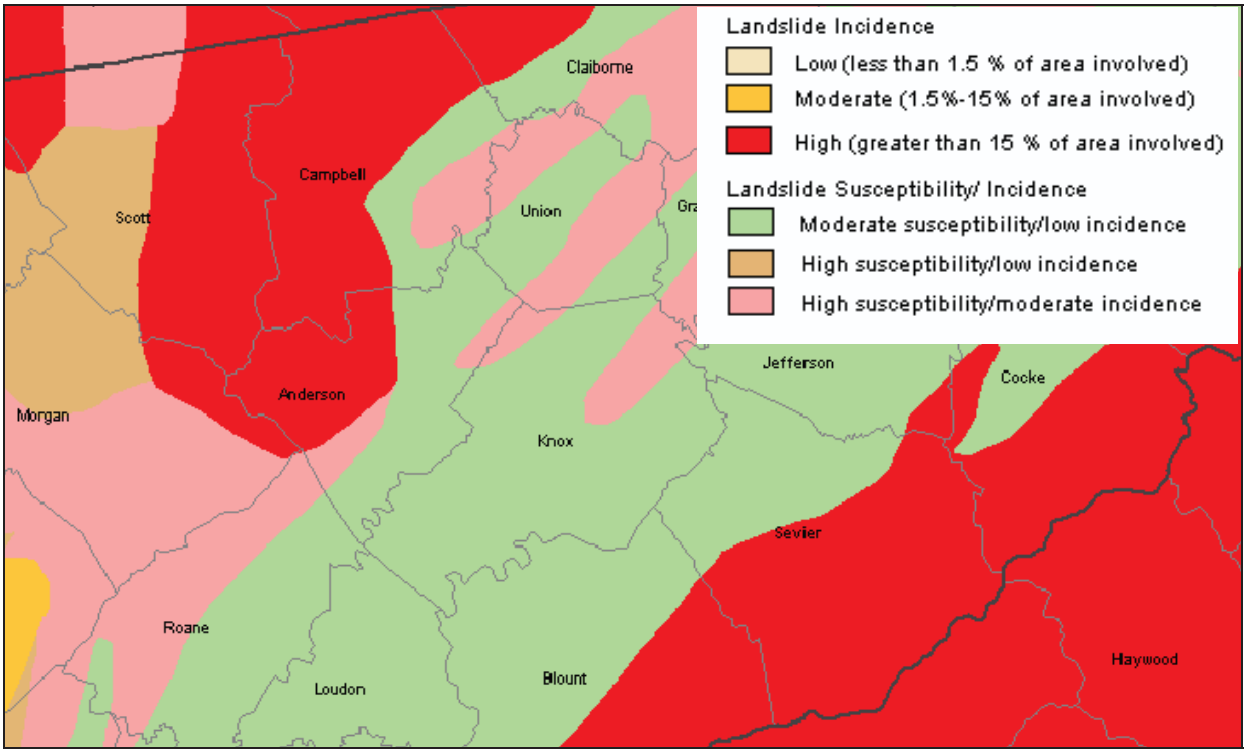
The term landslide is often used interchangeably with mass wasting. Mass wasting is essentially the downward movement of earth materials. The two forms of mass wasting

are classified as slope failures or sediment flows, the latter of which is often induced through the addition of water. They occur predominately in areas with steep slopes (such as slopes greater than 15 percent). They can be caused by both natural events (heavy rains, erosion, and earthquakes) and human-caused alterations to the land or a combination thereof. Generally, alterations to hillside and ridgetop land in Knox County are related to development activities and/or forestry practices. As slopes are cleared and graded, the likelihood of landslide events increases.

Geographic Location

The Landslide Incidence and Susceptibility map from USGS National Atlas website in Figure 3.32 shows areas of landslides and areas susceptible to future landsliding in Knox County. As this map demonstrates, all of Knox County has at least moderate susceptibility but low incidence of landslide (green shaded areas). There are two small areas, one at the northern boundary and another finger-like area in northeast Knox County that have high susceptibility and moderate incidence (areas shaded pink).

Figure 3.32. **Landslide Incidence and Susceptibility**



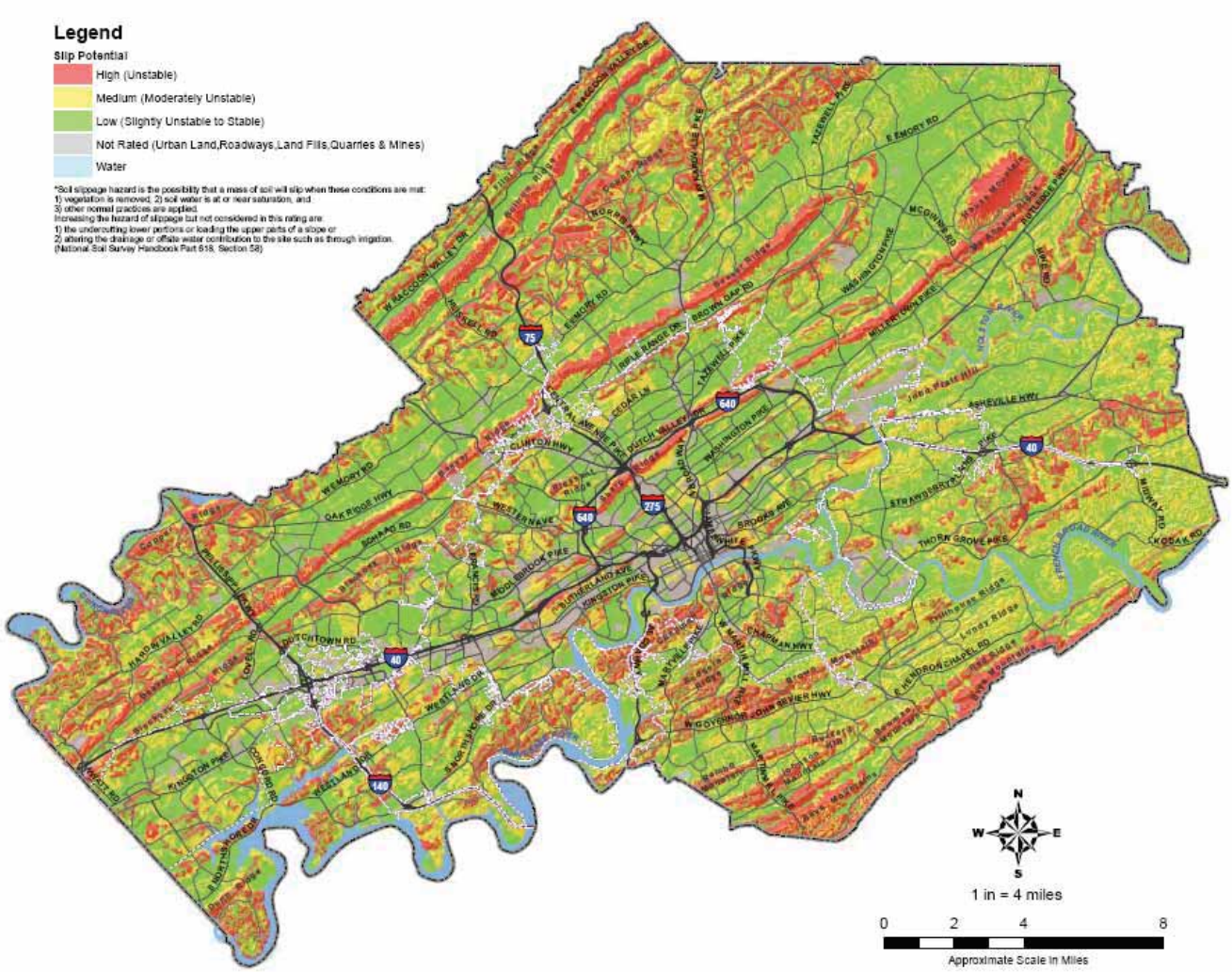
Source: U.S. Geological Survey National Atlas of the United States, April 28, 2011, http://nationalatlas.gov

Much of the remaining information in this section is from the Hillside and Ridgetop Protection Plan, which was adopted by the Metropolitan Planning Commission during development of this Hazard Mitigation Plan. The Hillside and Ridgetop Protection Plan

is currently under consideration by the Knoxville City Council and Knox County Commission.

Two major factors that contribute to an area being prone to landslide are soil slippage potential and slope. In evaluating soils and their capacity for development the Natural Resources Conservation Service (NRCS) Soil Survey for Knox County identifies soil types by slippage hazard. Soil slippage hazard is a measure of "the possibility that a mass of soil will slip." When vegetation is cleared, water saturates the soil and normal construction practices are applied (such as the application of heavy machinery) soil failure is more likely. Soil slippage hazard classes are identified as high (unstable), medium (moderately unstable) or low (slightly unstable to stable.) Classes are assigned based on observations of slope, mineral characteristics, strike and dip of bedrock geology, surface drainage patterns and occurrences of such features as slip scars and slumps. High slippage hazard soils are found predominately in steeply sloping hillside areas. Figure 3.33 provides the soil slippage potential map for Knox County.

Figure 3.33. **Soil Slippage Potential, Knox County, Tennessee**



Source: The Knoxville Knox County Hillside and Ridgetop Protection Plan_December 2010_DRAFT

Generally, slopes are measured as a percentage or as a ratio (rise/run). The terms slope and grade are often used interchangeably. Table 3.20 provides slope characteristics of land in Knox County and Figure 3.34 provides a map of the planning area with slope classifications.

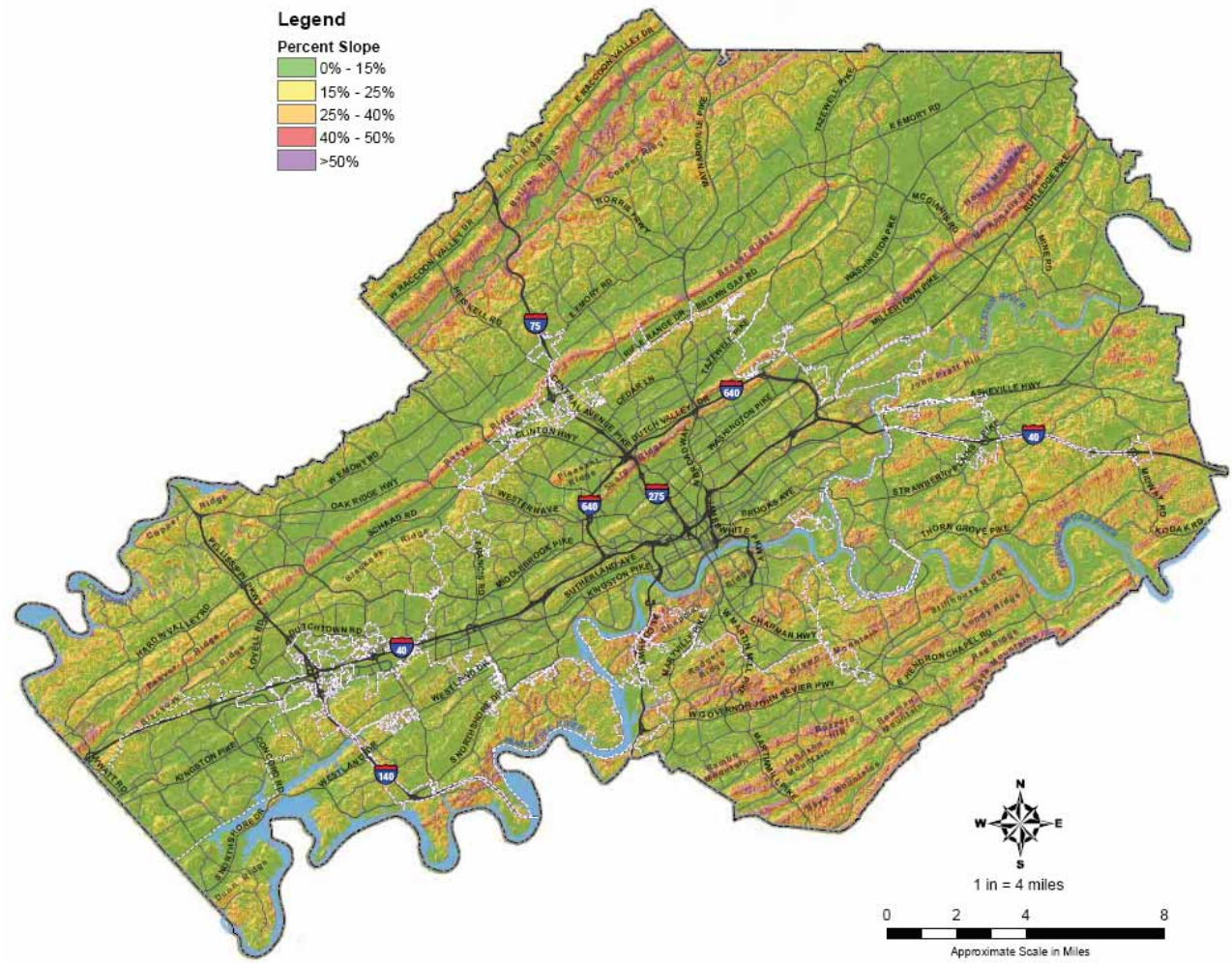
Table 3.20 Slope Characteristics in Knox County

Percent Slope	Acres	Percent of County (%)
0 - 15	225,464	67.0
15 - 25	62,346	18.5

25 - 40	34,127	10.1
40 - 50	8,847	2.6
>50	5,797	1.7
Total	336,581	100.0

Source: The Knoxville Knox County Hillside and Ridgetop Protection Plan_December 2010_DRAFT

Figure 3.34. **Slope Classifications in Knox County**



Source: The Knoxville Knox County Hillside and Ridgetop Protection Plan_December 2010_DRAFT

Previous Occurrences

- **August 2009**—A massive sediment flow originating from a cleared and graded hillside closed a road in the Wildwood Subdivision. Erosion and sediment control devices were not functioning properly on the site resulting in sediment spills over into an adjacent stream.

- **2003**—Improper clearing and grading during the construction of the Forest Ridge Apartments caused a landslide that destroyed an apartment building trapping and severely injuring an individual inside. Figure 3.35 and Figure 3.36 show the landslide from the up-slope and down-slope views respectively.

Figure 3.35. **2003 Forest Ridge Apartments Landslide**

The Knoxville Knox County Hillside and Ridgetop Protection Plan_December 2010_DRAFT.

Figure 3.36. **2003 Forest Ridge Apartments Landslide**

Source: Tennessee Department of Environment and Conservation-Division of Geology

Probability of Future Occurrences

There have been two documented damaging landslides in the ten year period from 2000-2009. This suggests a 20 percent probability of a damaging landslide in any given

year. In addition, it is probable that other smaller scale slides may have occurred that were not reported. Therefore, the HMPC agreed on a probability of "likely".

Magnitude/Severity

In general, when a landslide does occur, impacts are limited to a fairly small area and the magnitude of damages is "limited".

Landslide Hazard Summary

Although all parts of the planning area have some steep slopes and soil slippage potential, landslide frequency and spatial extent are lower in the Town of Farragut.

	Probability	Magnitude	Spatial Extent	Significance
Overall Planning Area	3-LIkely	2-Limited	2-Significant	2.45 (Medium)
Knox County	3-LIkely	2-Limited	2-Significant	2.45 (Medium)
City of Knoxville	3-LIkely	2-Limited	2-Significant	2.45 (Medium)
Town of Farragut	2-Occaisonal	2-Limited	1-Negligible	1.8 (Low)

3.2.9 Severe Storms (Hail, High Winds & Lightning)

Description

Thunderstorms are defined as localized storms, always accompanied by hail, lightning, damaging winds, heavy rain causing flash flooding (discussed separately in Section 3.2.6) and sometimes tornadoes (discussed separately in Section 3.2.10). Thunderstorms can produce a strong out-rush of wind known as a down-burst, or straight-line winds which may exceed 120 mph. These storms can overturn manufactured homes, tear roofs off of houses and topple trees.

According to the National Oceanic and Atmospheric Administration, approximately 10 percent of the thunderstorms that occur each year in the United States are classified as severe. The typical thunderstorm is 15 miles in diameter and lasts an average of 30 minutes. A thunderstorm is classified as severe when it contains one or more of the following phenomena:

- Hail measuring three quarters of an inch or larger in diameter; and/or
- Winds equal or exceed 58 mph.

A *severe thunderstorm watch* is issued by the National Weather Service when the weather conditions are such that a severe thunderstorm is likely to develop. They are normally issued well in advance of the actual occurrence of severe weather. During the watch, people should review severe thunderstorm safety rules and be prepared to move to a place of safety if threatening weather approaches.

A *severe thunderstorm warning* is issued when a severe thunderstorm has been sighted or indicated by weather radar. At this point, the danger is very serious and it is time to go to a safe place, turn on a battery-operated radio or television, and wait for the "all clear" from authorities.

Hail

Hail can occur when strong rising currents of air within a storm, called updrafts, carry water droplets to a height where freezing occurs. Then the grown ice particles fall to the ground. Severe thunderstorms can produce hail that can be three quarters of an inch or more in diameter and fall at speeds more than 100 mph. Hailstones of this size cause more than $1 billion in damages to properties and crops nationwide annually. Large hail can reach the size of grapefruit.

Based on information provided by the Tornado and Storm Research Organization, Table 2.21 describes typical damage impacts of the various sizes of hail.

Table 3.21 TORRO Hailstorm Intensity Scale

Intensity Category	Diameter (mm)	Diameter (inches)	Size Description	Typical Damage Impacts
Hard Hail	5-9	0.2-0.4	Pea	No damage
Potentially Damaging	10-15	0.4-0.6	Mothball	Slight general damage to plants, crops
Significant	16-20	0.6-0.8	Marble, grape	Significant damage to fruit, crops, vegetation
Severe	21-30	0.8-1.2	Walnut	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
Severe	31-40	1.2-1.6	Pigeon's egg > squash ball	Widespread glass damage, vehicle bodywork damage
Destructive	41-50	1.6-2.0	Golf ball > Pullet's egg	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
Destructive	51-60	2.0-2.4	Hen's egg	Bodywork of grounded aircraft dented, brick walls pitted
Destructive	61-75	2.4-3.0	Tennis ball > cricket ball	Severe roof damage, risk of serious injuries
Destructive	76-90	3.0-3.5	Large orange > Soft ball	Severe damage to aircraft bodywork
Super Hailstorms	91-100	3.6-3.9	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
Super Hailstorms	>100	4.0+	Melon	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Source: Tornado and Storm Research Organization (TORRO), Department of Geography, Oxford Brookes University
Notes: In addition to hail diameter, factors including number and density of hailstones, hail fall speed and surface wind speeds affect severity.

High Winds

A severe thunderstorm can produce winds that can cause as much damage as a weak tornado and these winds can be life threatening. The damaging winds of thunderstorms include downbursts, microbursts, and straight-line winds. Downbursts are localized currents of air blasting down from a thunderstorm, which induce an outward burst of damaging wind on or near the ground. Microbursts are minimized downbursts covering an area of less than 2.5 miles across. They include a strong wind shear (a rapid change in the direction of wind over a short distance) near the surface. Microbursts may or may not include precipitation and can produce winds at speeds of more than 150 miles per hour. Damaging straight-line winds are high winds across a wide area that can reach speeds of 140 miles per hour.

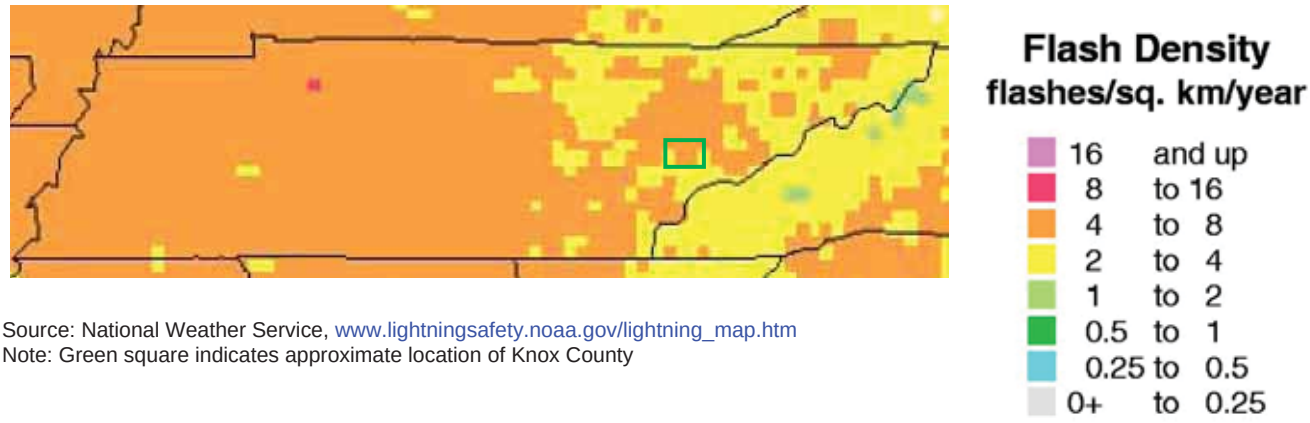
Figure 3.39 shows the wind zones of the United States based on maximum wind speeds; Tennessee is located within wind zones III and IV. All of the Knox County planning area is in zone III. High winds, often accompanying severe thunderstorms, can cause significant property and crop damage, threaten public safety, and have adverse economic impacts from business closures and power loss.

Lightning

Lightning is defined as any and all of the various forms of visible electrical discharge caused by thunderstorms. Lightning can occur from cloud-to-cloud, within a cloud, cloud-to-ground, or cloud-to-air. It causes an average of about 60 fatalities and 300 injuries each year when people are caught outdoors in the summer months during the afternoon and evening.

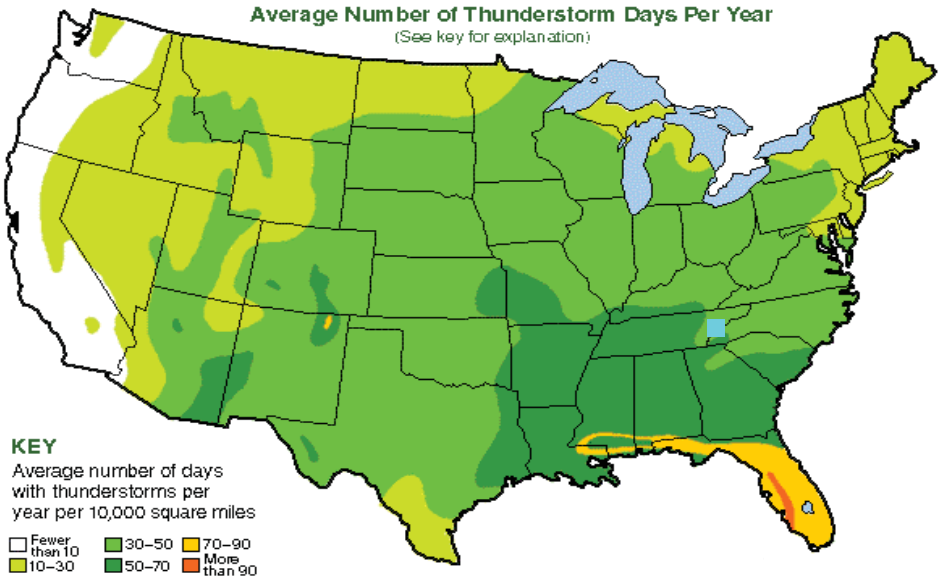
Figure 3.37and Figure 3.38 show Knox County located in an area with four to eight lightning strikes per square kilometer per year and with an average of 30-50 days with thunderstorms per year per 10,000 square miles.

Figure 3.37. **Annual Frequency of Lightning in Tennessee, 1996-2000**



Source: National Weather Service, www.lightningsafety.noaa.gov/lightning_map.htm
Note: Green square indicates approximate location of Knox County

Figure 3.38. **Average Number of Thunderstorm Days Per Year**



Source: Oklahoma Climatological Survey
Note: Blue square indicates approximate location of Knox County

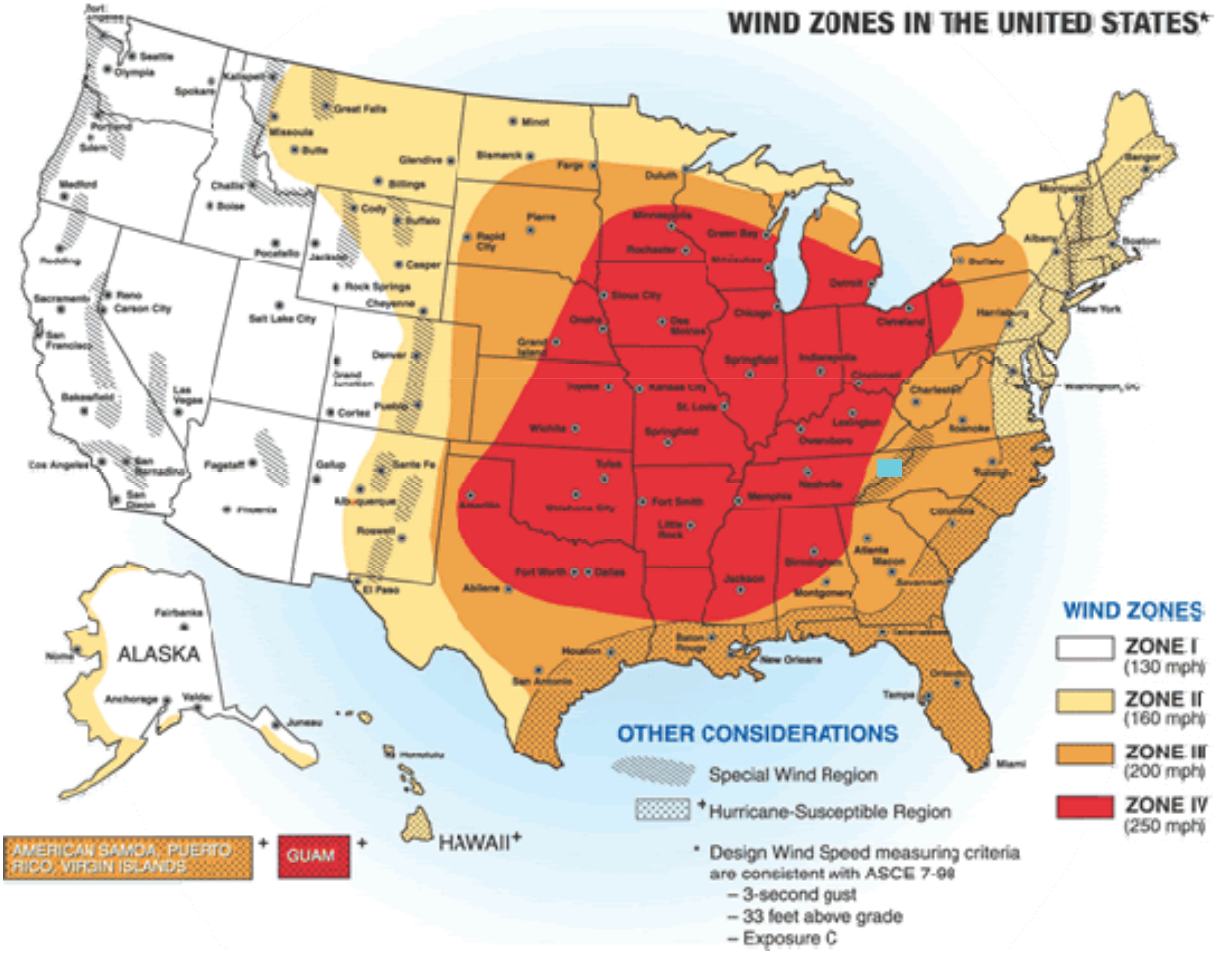
Geographic Location

Thunderstorms and the associated hail, high wind, and lightning impact the entire Knox County planning area. Thunderstorms over Tennessee typically occur in July, June, August, and May in that order according to Knoxville Local Climatological Data Annual Summary-1977 and Climatic Atlas of the United States by S S Visher.

They are usually produced by supercell thunderstorms or a line of thunderstorms that typically develop on hot and humid days.

All of Knox County is susceptible to high wind events, and all of the participating jurisdictions are vulnerable to this hazard. Figure 3.39 below shows Knox County (blue square approximates location on map) is in Wind Zone III. This zone of the United States can experience winds 160 to 200 mph.

Figure 3.39. **Wind Zones in the United States**



Source: FEMA; http://www.fema.gov/plan/prevent/saferoom/tsfs02_wind_zones.shtm
Note: Blue square indicates approximate location of Knox County

Previous Occurrences

Knox County has not been included in any presidential disaster declaration that specifically included high winds. However, generally, the events that included severe storms likely included high winds as well. For reference, the four declarations that Knox County received including severe storms are summarized below in Table 3.22. These events are also discussed separately in the flood and tornado profiles.

Table 3.22 Thunder Storm Disaster Declaration History in Knox County, 1965-Present

Declaration Number	Declaration Date (incident period)	Disaster Description
1464	5/8/2003 (5/4-30/2003)	Severe Storms, Tornadoes, and Flooding

Declaration Number	Declaration Date (incident period)	Disaster Description
1331	6/12/2000 (5/23-31/2000)	Severe Storms, Tornadoes, and Flooding
1215	4/20/1998 (4/16-5/18/1998)	Severe Storms, Tornadoes, and Flooding
151	3/27/1963	Severe Storms and Flooding

Source: FEMA

Hail

The NCDC reports 100 hail events in Knox County between 1962 and 2010. When limiting the list to those events considered destructive magnitude according to the TORRO Hail Intensity scale (1.75 in. diameter or larger), there were 20 events in the same 48 year period causing a reported $36,000 in property damage and $20,000 in crop damages. Table 3.23 shows the number of hail events by the size of the hail.

Table 3.23 Knox County Hail Events Summarized by Hail Size from 1962 to 2010

Hail Size	Number of Events	Property Damages
< 0.88 in	37	0
0.88 in.	10	$15,000
1.00 in.	29	$6,000
1.25 in.	1	$5,000
1.50 in.	3	0
1.75 in.	13	$10,000
2.00 in.	3	0
2.55 in.	2	0
2.75 in.	1	0
3.00 in.	1	0
Total	100	$36,000

Source National Climatic Data Center Storm Events Database

Figure 3.40. **Severe Storms with Hail on April 27, 2011**

Source: Photo by Adam Brimer. Hail falls outside the Knoxville News Sentinel.
http://www.knoxnews.com/photos/galleries/2011/apr/27/storms-across-tennessee-april-27/32199/#section_header

High Winds

According to the NCDC database, newspaper articles from the *Knoxville New Sentinel* and the *Knoxville Journal*, the planning area experienced 251 severe thunderstorms with high winds in excess of 58 miles per hour (50 knots) from 1950 to December 2010. Descriptions of the events are only provided from 1993 to 2010 and during this 18 year period there were 212 events causing nearly $3 Million in property damages, almost $500,000 in crop damages and two fatalities and four injuries reported. Also according to the Weather Forecasting Office in Morristown, Tennessee, July is the peak month for damaging winds with May being second.

Summaries of some of the more damaging events are provided below:

- **June 19, 2010**—Law enforcement personnel reported a few trees and power lines downed by thunderstorm winds in Knoxville causing approximately $12,000 in property damages.
- **June 21, 2009**—The local television station reported numerous trees downed by thunderstorm winds across the county with an early morning storm. A few homes and a church in Knoxville were also damaged by the winds causing approximately $18,000 in property damages.
- **June 12, 2008**—Dispatch reported several trees downed by thunderstorm winds in the Knoxville area. A tree fell on home in Knoxville damaging the roof.

- **December 1, 2006**—Wind speeds measured at 77 mph caused numerous trees and power lines to go down throughout East Tennessee causing approximately $600,000 in property damages.
- **June 13, 2004**—A tree was reported down on a home in the northern part of Knoxville. The home was damaged beyond repair
- **May 8, 2003-FEMA-1464-DR (period of incident May 4-30, 2003)**—This federal disaster declaration was made following severe storms, tornadoes, and flooding in Tennessee. This federal declaration mainly stems from a tornado outbreak in western and northwestern Tennessee on May 4, 2003. Knox County was added to this federal declaration after two tornadoes touched down in south Knoxville on May 15, 2003. This will be discussed further under the tornado hazard.
- **June 12, 2000-FEMA-1331-DR (period of incident May 23-31, 2000)**—This federal disaster declaration was made following severe storms, tornadoes, and flooding as severe thunderstorms and tornado moved across the central east Tennessee valley on May 23, 2000. An F1 tornado and severe straight line winds caused damage in the Powell community.
- **May 7, 1999**—Numerous trees and power lines down throughout the county. At least 9,000 homes were without power for a time.
- **April 20, 1998-FEMA-1215-DR (period of incident April 16-May 18, 1998)**—This federal disaster declaration was made following severe storms, tornadoes, and flooding in Tennessee. This federal declaration mainly stems from a tornado outbreak in middle Tennessee on April 16, 1998. This will be discussed further under the flood hazard.
- **May 24, 1996**—Numerous trees and power lines were blown down with only very minor injuries reported. The storm heavily damaged the stage set and lighting equipment of a country music singer causing $500,000 in property damages. Ping Pong ball size hail was reported by a television meteorologist.
- **October 5, 1995**—A large part of East Tennessee experienced high winds from the remnants of Hurricane Opal. Wind speeds at the higher elevations of the Appalachians were measured at 70 mph while 40-50 mph gusts were common at the lower elevations. Trees and power lines were down over much of the region. The greatest damage occurred in Hamilton County where damage was estimated in excess of $1 million. Over 20,000 homes were without power as a result of the storm. Over 70 miles of the Appalachian Trail was closed due to trees being down.
- **January 28, 1994**—Numerous trees were blown down and roofs were blown off all throughout southeast corner of the Tennessee. A building containing 6 helicopters was destroyed in Maryville, which is in very close proximity to Knoxville.
- **November 19, 1988**—Gale force winds estimated at 100 mph caused $1 million in damages.
- **July 3, 1982**—Winds over 50 mph caused power outages in County.
- **January 27, 1974**—Gale force winds caused $100,000 in damages in the Deane Hill area.

- **February 27, 1963-FEMA-151-DR**—This federal disaster declaration was made following severe storms and heavy rains caused urban flooding in the planning area. This will be discussed further under the flood hazard.

Most of the events in the NCDC database included reports of downed trees and power lines. Although many of these events did not report damages to property or crops, debris removal and other associated costs are common as a result of the numerous high wind events.

According to the USDA Risk Management Agency data from 2001 through 2010, insurance payments for damages to the burley tobacco crop occurred in 2008 totaled $1,951. It was a result from remnants of Hurricane Ike. Also state-wide in Tennessee, 82 percent of the row crops were insured in 2010 according to the USDA Risk Management Agency.

Lightning

From 1995 to 2010, the County only has two reported lightning events, which is presumed to be a low reported number of lightning events. Lighting events were not reported in NCDC prior to 1994. Therefore a shorter time-period of statistics is available. The following are the events listed in NCDC:

- **August 4, 2006**—Lightning struck and damaged an apartment building on Middle Brook Pike in Knoxville. One unit was destroyed as the roof caught fire causing $25,000 in estimated damages.
- **September 1, 1995**—Lightning struck and damaged a houses causing $45,000 in estimated damages.

Probability of Future Occurrences

According to NCDC, there were 251 wind events in Knox County between 1950 and 2010 (60 years). Based on this information, the probability that at least one significant wind event with 50 knots or higher will occur in Knox County in any given year is “highly likely” with an annual average of 4.18 events per year.

Based on the reported 20 events in the NCDC database of hail events with hail 1.75 inches in diameter and larger occur an average of .42 times per year in the planning area from 1962 to 2010.

National Weather Service data indicates that Knox County is in a region that receives four to eight lightning strikes per square kilometer per year. However, most of these lightning strikes do not result in damages and that is reflected in the small amount of historical data reported in the NCDC database.

Seasonally, thunderstorms are more likely to occur during the summer months of May, June, and July. These rates of occurrence are expected to continue in the future.

Magnitude/Severity

Estimated damages from thunderstorms (including hail, high winds, and lightning) in the NCDC database for the 18 year period were reported to be $2.566 Million in property damages. Many damages and costs as a result of such events are often not reported. So, these estimates can be considered to be very conservative. Common types of damages were structural damages caused by falling limbs and debris, roof damages, overturned vehicles and light structures, and downed power poles resulting in some loss of electric service. In addition, clearance of the debris left behind can be costly and is generally not reported in damage estimates in NCDC. The HMPC rated the potential magnitude/severity is considered “limited”.

Severe Storms Hazard Summary

	Frequency of Occurrence	Magnitude	Spatial Extent	Ranking
Overall Planning Area	4-Highly Likely	2-Limited	3 Extensive	3.1 (High)
Knox County	4-Highly Likely	2-Limited	3 Extensive	3.1 (High)
City of Knoxville	4-Highly Likely	2-Limited	3 Extensive	3.1 (High)
Town of Farragut	4-Highly Likely	2-Limited	3 Extensive	3.1 (High)

3.2.10 Tornadoes

Description

The National Weather Service defines a tornado as a “violently rotating column of air extending from a thunderstorm to the ground.” Tornadoes are the most violent of all atmospheric storms and are capable of tremendous destruction. Wind speeds can exceed 250 mph, and damage paths can be more than one mile wide and 50 miles long. In an average year, more than 900 tornadoes are reported in the United States, resulting in approximately 80 deaths and more than 1500 injuries. High winds not associated with tornadoes are profiled separately in this document in Section 3.2.9, Thunderstorms/High Winds.

In Tennessee, most tornadoes and tornado-related deaths and injuries occur during the months of April, May, and June. However, tornadoes have struck in every month. Similarly, while most tornadoes occur between 3:00 and 9:00 p.m., a tornado can strike at any time.

Prior to February 1, 2007, tornado intensity was measured by the Fujita (F) scale. This scale was revised and is now the Enhanced Fujita scale. Both scales are sets of wind estimates (not measurements) based on damage. The new scale provides more

damage indicators and associated degrees of damage, allowing for more detailed analysis, better correlation between damage and wind speed. It is also more precise because it takes into account the materials affected and the construction of structures damaged by a tornado.

Table 3.24 shows the wind speeds associated with the original Fujita scale ratings and the damage that could result at different levels of intensity.

Table 3.24 Original Fujita Scale

Fujita (F) Scale	Fujita Scale Wind Estimate (mph)	Typical Damage
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena will occur.

Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/f-scale.html

Table 3.25 below shows wind speeds associated with the Enhanced Fujita Scale ratings. The Enhanced Fujita Scale's damage indicators and degrees of damage can be found online at www.spc.noaa.gov/efscale/ef-scale.html.

Table 3.25 Enhanced Fujita Scale

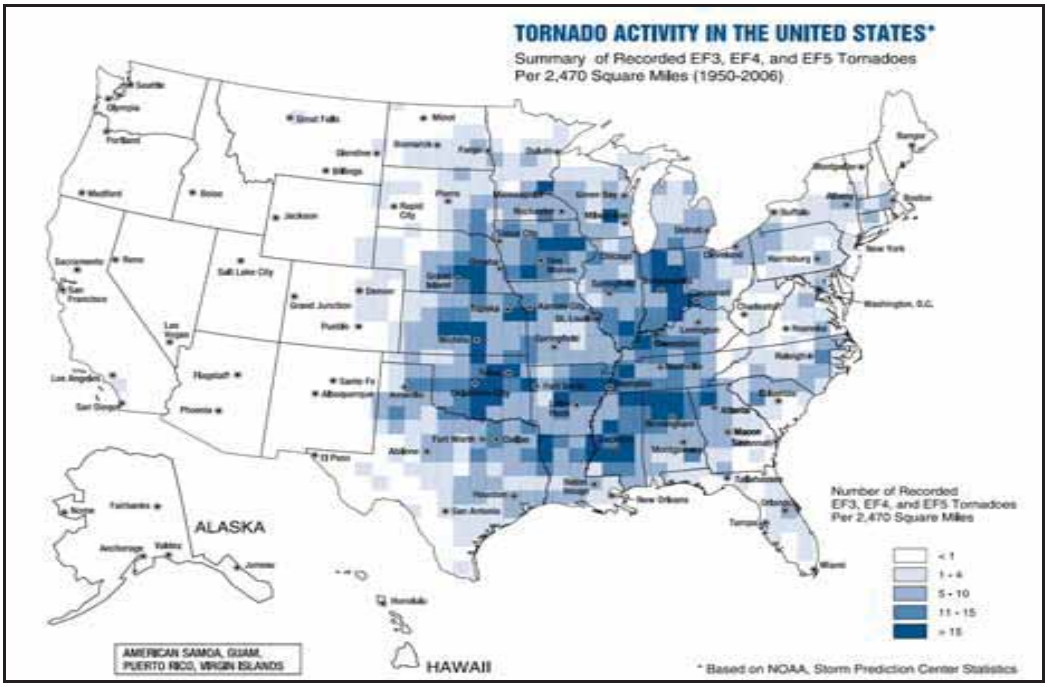
Enhanced Fujita (EF) Scale	Enhanced Fujita Scale Wind Estimate (mph)
EF0	65-85
EF1	86-110
EF2	111-135
EF3	136-165
EF4	166-200
EF5	Over 200

Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/ef-scale.html

Geographic Location

While tornadoes can occur in all areas of the State of Tennessee, historically, some areas of the State have been more susceptible to this type of damaging storm. 0 illustrates the number of F3, F4, and F5 tornadoes recorded in the United States per 2,470 square miles between 1950 and 2006. Knox County is located within the region shaded light blue indicating 1-4 tornadoes of this magnitude during this 57-year period which is on the lower end of the frequency spectrum. The ridges and valleys characteristic of East Tennessee minimize the risk from tornadoes in Knoxville.

Knox County planning area is not located within the boundaries of “Tornado Alley”, which is an area in the United States that receives more tornadoes than anywhere else besides Florida. Tornadoes within “Tornado Alley” can reach Category EF3 and above on the Enhanced Fujita Scale, which are considered to be strong to violent tornadoes.



Tornado Activity in the United States, 1950-2006 Source: National Oceanic and Atmospheric Administration: Note: Red Square is the approximate location of Knox County

Previous Occurrences

According to the NCDC database, there were ten separate tornado events in Knox County between 1950 and December 2010 (listings on the same date at different

locations were considered multiple events). Combined damages of these events were 2 fatalities, 31 injuries, and over $7.9 Million in reported property damages. Of these previous events, three were rated F0, four were rated F1, two were rated F2, one was rated F3. Table 3.26 summarizes these events.

Knox County has been included in three presidential disaster declarations that involved tornadoes since 1955 (see details below under DR-1464, DR-1331, and DR-424).

Table 3.26 Recorded Tornadoes in Knox County, 1950-2010.

Date	Time (LST)	Fatalities	Injured	Path Length (miles)	Magnitude	Location	Property Damage $
April 15, 1965	5:30 PM	0	6	7.4	F2	near Concord to Bearden	$2.5 M
April 4, 1974	12:30 AM	2	21	4.0	F2	near Sunrise and Skaggston	$25,000
May 27, 1981	7:40 PM	0	0	0.4	F0	near Karns	$25,000
February 21, 1993	5:05 PM	0	0	6.0	F3	Powell to Northbrook	$5.0 M
June 30, 1993	7:00 PM	0	1	2.0	F0	near Halls Crossroads	0
June 30, 1993	7:42 PM	0	0	1.0	F0	Knoxville	0
May 18, 1995	9:00 PM	0	0	2.0	F1	Fountain City	0
May 23, 2000	4:05 PM	0	1	0.5	F1	Powell	0
May 15, 2003	5:10 PM	0	0	1.0	F1	south Knoxville	$150,000
May 15, 2003	5:15 PM	0	0	1.3	F1	south Knoxville	$200,000
Total		2	31				$7.9 M

Source: National Climatic Data Center

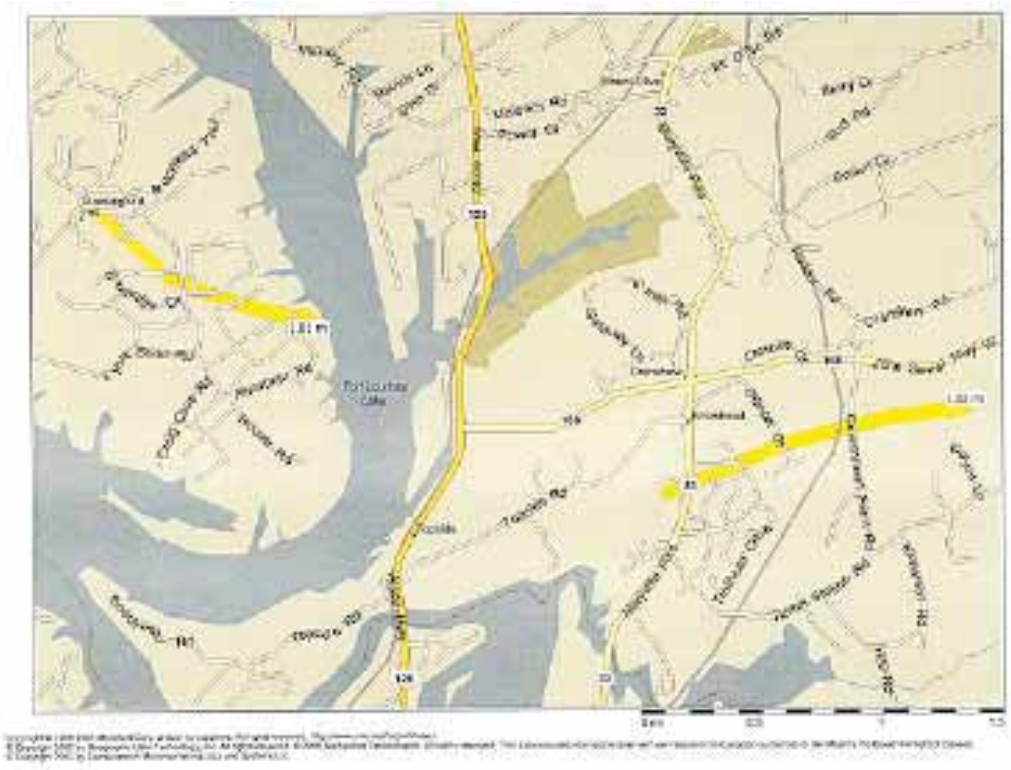
Descriptions of the more damaging events are provided below:

- **May 8, 2003-FEMA-1464-DR (period of incident May 4-30, 2003)**—This federal disaster declaration was made following severe storms, tornadoes, and flooding in Tennessee. This federal declaration mainly stems from a tornado outbreak in western and northwestern Tennessee on May 4, 2003. Knox County was added to this federal declaration after two tornadoes touched down in south Knoxville on May 15, 2003. The first tornado was reported at 5:10 p.m. near the Lyons Bend area (traveling around a mile on the ground). It downed numerous power lines and

approximately 100 trees. Downed trees at the Cherokee Country Club damaged a cart barn and a pump house.

The second and final tornado was reported at 5:15 p.m. south of John Sevier Highway near Apache Trail. This second tornado traveled 1.3 miles and lifted near the intersection of Martinmill Pike and Tipton Station Road. The tornado downed numerous power lines and traffic signals. Also, several buildings at a residence on Ottinger Road were damaged. Six condominiums were damaged at 700 Idlewood Lane as tornadic wind gusts downed a huge tree on the structures. Radar reflectivity images continued to reveal indications of a 'hook echo'. Both tornadoes were rated F1 on the Fujita tornado intensity scale. This supercell storm continued moving southeast into Blount and Sevier Counties, with quarter to golf ball hail reported in both counties.

Figure 3.41. **Tracks of the Knox County Tornadoes on May 15, 2003.**



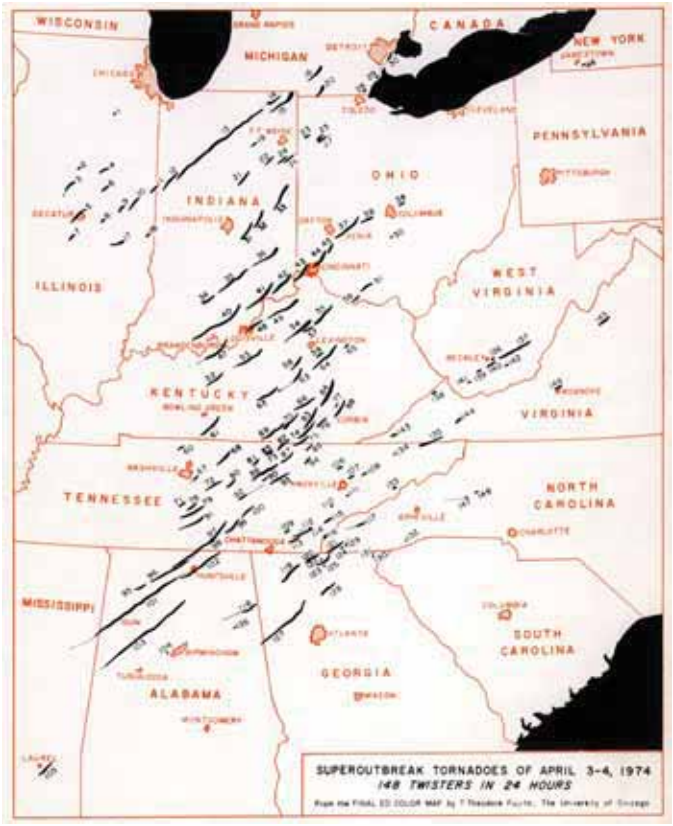
Source: National Weather Service Weather Forecast Office, Morristown, TN, http://www.srh.noaa.gov/mrx/svrevnts/may15tornadoes/trackmap.php

- **June 12, 2000-FEMA-1331-DR (period of incident May 23-31, 2000)** —This federal disaster declaration was made following severe storms, tornadoes, and flooding as severe thunderstorms and tornado moved across the central east Tennessee valley on May 23, 2000. An F1 tornado and severe straight line winds

caused damage in the Powell community and a resident of the Impala Mobile Home Park, was injured after the storm ripped his home off its foundation.

- **May 18, 1995**—In North Knox, an EF1 tornado caused damage to homes, trees and power lines. One tree knocked down was 151-years-old.
- **February 21, 1993**—The EF3 tornado started near Oak Ridge, moved through the Bull Run Steam Plant and went through the town of Claxton. Fifty homes were damaged and six manufactured homes were destroyed. Two businesses were destroyed and another ten were damaged including a weapons plant. Twelve electric transmission towers were knocked down.
- **April 4, 1974-FEMA-424-DR (period of incident April 3-4, 1974)** —Between the early afternoon of April 3 and 1:00 a.m. April 4th, there were at least 28 tornadoes in 19 Tennessee counties in the worst single outbreak of tornadoes in the State's history. The storms left 45 people dead, 749 injured, and caused approximately $22 million in property damages throughout central and eastern Tennessee. The last tornado was an isolated one that occurred about ten miles northeast of Knoxville. It struck a manufactured home park, killing two children and injuring 21 people in Knox County.

Figure 3.42. **Widespread Tornado Outbreak of April 3-4, 1974**



Source: National Oceanic and Atmospheric Administration

Probability of Future Occurrences

Based on NCDC records of ten tornadoes in a 60-year period, there is a 16 percent probability of a tornado in Knox County in any given year thus ranking it as “likely”. Removing the F0 rated events from this calculation, there were 7 tornadoes in the same period resulting in a probability 12 percent probability in any given year.

Magnitude/Severity

Historically, the ridges and valleys characteristic of East Tennessee have minimize the risk from tornadoes in Knoxville. Since Knoxville is not located within “Tornado Alley,” its tornadoes can generally be assumed to be anywhere from Category F0 to F2 on the Enhanced Fujita Scale. In the United States, 80 percent of all tornadoes are Category EF0 or EF1, so the likelihood of a higher intensity tornado occurring in Knoxville is not high. Category EF0 to EF2 tornadoes range from causing light damage to considerable damage thus the potential magnitude/severity is considered to be rated as “limited”.

Tornadoes Hazard Summary

	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	3-LIkely	2-Limited	1-Limited	2.25 (Medium)
Knox County	3-LIkely	2-Limited	1-Limited	2.25 (Medium)
City of Knoxville	3-LIkely	2-Limited	1-Limited	2.25 (Medium)
Town of Farragut	3-LIkely	2-Limited	1-Limited	2.25 (Medium)

3.2.11 Wildfire

Description

Heavily wooded or forested areas cover less than 25 percent of Knox County’s total land area. However, when the conditions are right, these areas become vulnerable to wildfires. Also, in the last few decades, the risks associated with Knox County’s wildfire hazard have increased due to the increase in wildland/urban interface (areas where development occurs within or immediately adjacent to wildlands, near fire-prone trees, brush, and/or other vegetation), more and more structures and people are at risk. Between 1985 and 1994, wildfires destroyed more than 9,000 homes in the wildland/urban interface areas of the United States.

On occasion, farmers intentionally ignite vegetation to restore soil nutrients or alter the existing vegetation growth. These fires have the potential to erupt into wildfires. But the main culprit of wildfires in the County and throughout the U.S. is caused by careless or unintentional activities of people. These fires start in or near where people live or where people choose to do recreational activities. Table 3.27 shows that 88 percent of the wildland fires in the U.S. were human caused.

Table 3.27 10-Year Average of Wildland Fire Causes (1988-1997)

	Human Cause	Lightning Cause
Number of Fires	102,694	13,879
Percent of Fires	88	12
Acres Burned	1,942,106	2,110,810
Percent of Acreage	48	52

Generally, there are three major factors that sustain wildfires and allow for predictions of a given area's potential to burn. These factors include:

- Fuel;
- Topography; and
- Weather.

Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is generally classified by type and by volume. Fuels sources are diverse and include everything from dead tree needles, twigs, and branches to dead standing trees, live trees, brush, and cured grasses. Man-made structures and other associated combustibles are also to be considered as a fuel source. The type of prevalent fuel directly influences the behavior of wildfire. Light fuels such as grasses burn quickly and serve as a catalyst for spreading wildfires.

An area's topography (terrain and land slopes) affect its susceptibility to wildfire spread. Fire intensities and rates of spread increase as slope increases due to the tendency of heat from a fire to rise via convection. The natural arrangement of vegetation throughout a hillside can also contribute to increased fire activity on slopes

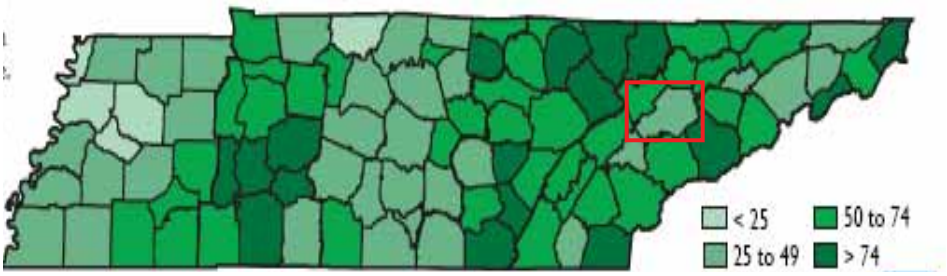
Weather components such as temperature, relative humidity, wind, and lightning also affect the potential for wildfire. High temperatures and low relative humidity dry out the fuels that feed the wildfire creating a situation where fuel will more readily ignite and burn more intensely. Wind is the most treacherous weather factor. The issue of drought conditions contributes to concerns about wildfire vulnerability.

Geographic Location

The entire planning area is subject to incidents of wildfire. In general, Tennessee has two fire seasons a year: in the spring about February 15th and ends near May 15th when the forest has "greened up"; and in the fall around October 15th when the leaves begin to fall and usually ends December 15th due to shorter, cooler, wetter days.

In Figure 3.43 below, it depicts the percentage of land in forest by county. Knox County is light green shaded thus reflecting less than 25 percent of the County is in forest.

Figure 3.43. **Percentage of Land in Forest by County, 2004**



Source: Forest Inventory & Analysis Factsheet, Tennessee 2004, http://www.state.tn.us/agriculture/publications/forestry/FIA-2004_factsheet_%20TN_2007revision.pdf
Note: Red square shows location of Knox County.

Previous Occurrences

According to the Tennessee Department of Agriculture, Division of Forestry, Knox County has had 46 wildfires that burned 840 acres between 2006 and 2010. There were no fatalities or injuries reported in association with these wildfires and no structural damage. Table 3.28 details wildfire occurrences in Knox County from 2006-2010 from the following reporting fire departments: Heiskell Volunteer Fire Department (VFD), Karns VFD, Knoxville City Fire Department, Rural Metro Fire Department, and Seymour VFD.

Table 3.28 Wildfires, Knox County, 2006-2010

Year	# Fires	Acres Burned
2006	6	21
2007	16	513
2008	7	119
2009	11	177
2010	6	10
Totals	**46**	**840**

Source: Tennessee Department of Agriculture, Division of Forestry, Incident Fire Reporting System

Also debris burning is the number one ranking cause of these wildfires in Knox County, followed by arson, campfires, power lines, children, and sparks from railroad lines.

Probability of Future Occurrences

Wildfires occur in Knox County on an annual basis. The average number of wildfires per year for the 5-year period from 2006-2010 was 9.2. The planning committee anticipates that this rate of occurrence is likely to continue. Future occurrences of this hazard are likely to increase if development in wildland-urban interface areas increases.

Magnitude/Severity

Wildfires occur on an annual basis. With the history of no fatalities or injuries and no structural damage during the 2006-2010 reporting period, the potential magnitude/severity is considered to be “negligible”.

Wildfire Hazard Summary

	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	4-Highly Likely	1-Negligible	1-Limited	2.35 (Medium)
Knox County	4-Highly Likely	1-Negligible	1-Limited	2.35 (Medium)
City of Knoxville	4-Highly Likely	1-Negligible	1-Limited	2.35 (Medium)
Town of Farragut	4-Highly Likely	1-Negligible	1-Limited	2.35 (Medium)

3.2.12 Winter Storms

Description

Winter storms in Tennessee typically involve snow and/or freezing rain (ice storms). These conditions pose a serious threat to public safety, disrupt commerce and transportation, and can damage utilities and communications infrastructure. Winter storms can also disrupt emergency and medical services, hamper the flow of supplies, and isolate homes and farms. Heavy snow can collapse roofs and down trees onto power lines. Direct and indirect economic impacts of winter storms include cost of snow removal, damage repair, increased heating bills, business and crop losses, power failures and frozen or burst water lines.

The National Weather Service describes different types of winter storm conditions as follows:

- **Blizzard**—Winds of 35 mph or more with snow and blowing snow reducing visibility to less than 1/4 mile for at least three hours.
- **Blowing Snow**—Wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground picked up by the wind.
- **Snow Squalls**—Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant.
- **Snow Showers**—Snow falling at varying intensities for brief periods of time. Some accumulation is possible.
- **Freezing Rain**—Measurable rain that falls onto a surface whose temperature is below freezing. This causes the rain to freeze on surfaces, such as trees, cars, and roads, forming a coating or glaze of ice. Most freezing-rain events are short lived and occur near sunrise between the months of December and March.
- **Sleet**—Rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects.

Duration of the most severe impacts of winter storms is generally less than one week, though dangerous cold, snow, and ice conditions can remain present for longer periods in certain cases. Weather forecasts commonly predict the most severe winter storms at least 24 hours in advance, leaving adequate time to warn the public.

Geographic Location

The entire State of Tennessee is vulnerable to light snow and freezing rain. The eastern region of Tennessee including Knox County receives 11.5 inches of snow during a normal season according to the National Weather Service in Morristown, Tennessee.

The average monthly snowfall, including ice pellets and sleet for Knoxville is presented in Table 3.29 below.

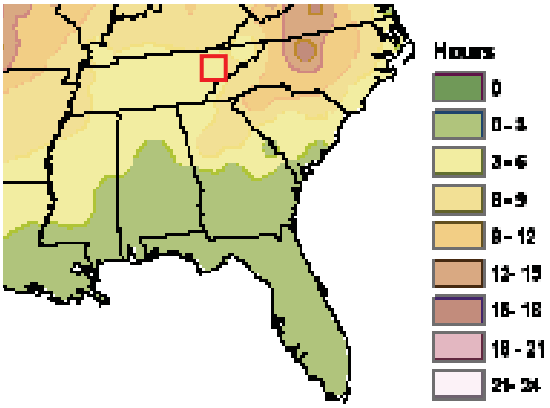
Table 3.29 Snowfall Summary (inches) 1944-2002 National Climatic Data Center Averages

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Knoxville, TN	3.9	3.4	1.7	0.4	0	0	0	0	0	0	0.6	1.5	11.5

Source: http://lwf.ncdc.noaa.gov/oa/climate/online/ccd/snowfall.html

Figure 3.44 shows that Knox County and most of the State of Tennessee falls in a zone that receives 3-6 hours of freezing rain per year.

Figure 3.44. **Average Number of Hours per Year with Freezing Rain in the United States**



Source: American Meteorological Society. "Freezing Rain Events in the United States." http://ams.confex.com/ams/pdfpapers/71872.pdf.
Note: Red square indicates approximate location of Knox County

Previous Occurrences

Of the six Major Presidential Disaster Declarations and two emergency declarations that have occurred in Knox County since 1963, one emergency declaration has been related

to winter storms in 1993. Also 27 events have occurred in Knox County between October 1993 and December 2010 and are reported from NCDC records. Occurrences listed prior to 1993 are from newspaper articles either the *Knoxville New Sentinel* or the *Knoxville Journal*.

- **January 29, 2005**—A low pressure system spread moist air above a cold air mass in place at the surface across East Tennessee creating a mixture of freezing rain and sleet across the lower elevations and a mixture of sleet and snow across the higher terrain. Much of the region ended up with ice accumulation around one quarter inch with some locations measuring as much as one half inch of ice. Trees and power lines were downed across parts of the region due to ice accumulation.
- **February 28, 2004**—The planning area received three to six inches of snow.
- **January 22, 2003**—The planning area received two to five inches of snow.
- **December 3, 2000**—Widespread snow fell across East Tennessee. Amounts varied widely. In northeast Tennessee, snowfall amounts averaged 1 to 3 inches, with a few spots in the mountains reporting 2 to 4 inches. In central East Tennessee, amounts ranged between 1 and 3 inches, with a few isolated reports of 3 to 5 inches. In southeast Tennessee, amounts were a bit heavier. Snowfall amounts averaged 2 to 4 inches, with a few places reporting 3 to 5 inches.
- **December 1998**—Snow and ice storm cause extensive power outages across planning area.
- **February 1, 1996**—14-16 inches of snow across planning area.
- **February 7, 1995**—Snow fell across of Tennessee with accumulation of two to four inches over most areas. Parts of middle and east Tennessee had snow drifts of up to three feet in depth.
- **February 4, 1994**—A major ice storm hit much of Tennessee. Numerous trees were knocked down. Many of these trees took down power lines as well. About 770,000 people in the State lost power for some period of time.
- **March 14, 1993-FEMA-3095-DR (period of incident March 13-17, 1993)** —Light snow began to fall on Friday night March 12th. Low pressure was rapidly intensifying along the Gulf Coast and started moving northeast. The track of the storm was a perfect snow maker for Knox County planning area as it moved through northern Georgia, then up through the Carolinas and into the northeast. The strength of the low pressure and the intensity of the wind make this storm significant. 40,000 of 153,000 without power in many areas for more than a week, forcing shelters to be opened and schools to close. National Weather Service recorded 11.13 inches for Knoxville on March 13th. The total disaster cost for the public in this planning area was $846,337.14.
- **April 3, 1987**—Winter storm caused 25,000 customers to be without power and caused $570,000 in damages.
- **December 26, 1983**—Ice storm caused 10 fatalities and millions in damages.

- **January 17, 1982**—Planning area had 1/8 inch of ice accumulations. It closed the interstates and the Oak Ridge area was without power.
- **January 24, 1978**—Rain, snow, and 51 mph winds caused Tennessee Valley Authority to have power shortages.
- **January 1976**—Ice storm caused numerous car accidents and property damage.
- **December 30, 1963**—10 inches of snow in the planning area.
- **January 8, 1962**—12 inches of snow in the planning area.
- **February 13-14, 1960**—17.5 inches of snow in the planning area.
- **Winter 1959-1960**—Worst recorded winter with 56.7 inches in the season.
- **November 21-22, 1952**—30,000 of 65,000 customers without power with 18.2 inches of snow.
- **December 4-6, 1886**—22.5 inches of snow in planning area.

Probability of Future Occurrences

With the combined historical information from FEMA declarations, planning committee accounts, and the NCDC database, during an 18-year period from 1993 to 2010 there were at 27 recorded winter storm events (snow and ice) in Knox County resulting in an average of one and a half winter storms per year. Based on historic frequency, the probability of future occurrence rating for winter storms is 100 percent in any given year.

Magnitude/Severity

Damages associated with winter storms in Knox County are usually related to downed power lines and power infrastructure. These damages and the associated losses as a result of disruptions in normal daily operations can be costly.

One significant winter weather event can have multiple impacts including property damage and damages to power lines and infrastructure from falling trees and limbs, prolonged power outages, road damage, road hazards, and road closures, school, government and business closures.

Winter Storm Hazard Summary

	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	4-Highly Likely	1-Negligible	3-Extensive	2.75 (Medium)
Knox County	4-Highly Likely	1-Negligible	3-Extensive	2.75 (Medium)
City of Knoxville	4-Highly Likely	1-Negligible	3-Extensive	2.75 (Medium)
Town of Farragut	4-Highly Likely	1-Negligible	3-Extensive	2.75 (Medium)

3.2.13 Hazard Profiles Summary

Table 3.30 summarizes the results of the hazard profiles and how each hazard varies by jurisdiction. This assessment was used by the HMPC to prioritize those hazards of greatest significance to each jurisdiction, enabling the jurisdictions to focus resources where they are most needed and develop the mitigation strategy accordingly.

Table 3.30 Planning Significance of Identified Hazard by Jurisdiction

Hazard	Knox County	City of Knoxville	Town of Farragut
Dam Failure	1.55-L	1.55-L	1.0-L
Drought	1.8-L	1.8-L	1.8-L
Earthquake	2.3-M	2.3-M	2.3-M
Expansive Soils	1.0-L	1.0-L	1.0-L
Extreme Temperatures	3.1-H	3.1-H	3.1-H
Flood	3.1-H	3.1-H	1.9-L
Land subsidence & sinkholes	2.9-M	2.9-M	2.25-M
Landslides	2.45-M	2.45-M	1.8-L
Severe Storms	3.1-H	3.1-H	3.1-H
Tornadoes	2.25-M	2.25-M	2.25-M
Wildfires	2.35-M	2.35-M	2.35-M
Winter Storm	2.75-M	2.75-M	2.75-M

Source: HMPC, Note: H = High, M = Medium, L = Low

3.3 Vulnerability Assessment

Requirement §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. This description shall include an overall summary of each hazard and its impact on the community.

Requirement §201.6(c)(2)(ii)(A) :The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas.

Requirement §201.6(c)(2)(ii)(B) :[The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] 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.

Requirement §201.6(c)(2)(ii): (As of October 1, 2008) [The risk assessment] must also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged floods.

3.3.1 Methodology

The vulnerability assessment further defines and quantifies populations, buildings, critical facilities, and other community assets at risk to natural hazards. The vulnerability assessment for this plan followed the methodology described in the FEMA publication *Understanding Your Risks—Identifying Hazards and Estimating Losses* (2002).

The vulnerability assessment was conducted based on the best available data and the significance of the hazard. Data to support the vulnerability assessment was collected from the following sources:

- FEMA's HAZUS-MH MR5 loss estimation software
- Written descriptions of assets and risks provided by participating jurisdictions
- Existing plans and reports
- Personal interviews with HMPC members and other stakeholders
- Other sources as cited

The Vulnerability Assessment is divided into four parts:

- **Section 3.3.2 Community Assets** first describes the assets at risk in Knox County, including the total exposure of people and property; critical facilities and infrastructure; natural, cultural, and historic resources; and economic assets.
- **Section 3.3.3 Vulnerability by Hazard** describes the vulnerability to each hazard identified in section 3.1 and profiled in section 3.2. This vulnerability analysis includes a vulnerability overview for each hazard. For hazards of high and moderate significance, the vulnerability analysis includes evaluation of vulnerable buildings, infrastructure, and critical facilities; estimated losses and a description of the methodology used to estimate losses; discussion of future development in relation to hazard-prone areas.
- **Section 3.3.4 Future Land Use and Development** discusses development trends, including population growth, housing demand, and future projects.
- **Section 3.3.5 Summary of Key Issues** summarizes the key issues and conclusions identified in the risk assessment process.
-

3.3.2 Community Assets

This section assesses the population, structures, critical facilities and infrastructure, and other important assets in Knox County that may be at risk to natural hazards.

Total Exposure of Population and Structures

Table 3.31 shows the total population from the 2000 census data, building count, estimated value of buildings, estimated value of contents and estimated total exposure to parcels by jurisdiction. This information was derived from inventory data associated with FEMA's loss estimation software HAZUS-MH MR5, the latest version of the software available during development of this plan. Population data is also provided in this table from the 2010 census data (provided by the Knox County GIS (KGIS)) to show the most recent population data available. However, please note that HAZUS MR5 uses 2000 census data as the basis to determine displaced populations/households and loss estimates. As discussed in the Vulnerability by Hazard section that follows, HAZUS was used to determine vulnerability and loss estimates for dam failure, earthquake, and flood.

As demonstrated by the information provided below, the greatest exposure of people and building counts is in the unincorporated county. However, the highest building and contents exposures are in the City of Knoxville.

Table 3.31 Maximum Population and Building Exposure by Jurisdiction

Jurisdiction	2010 Population	2000 Population	Building Count	Building Exposure	Contents Exposure	Combined Building/contents Exposure
Knox County (Unincorporated)	237,660	189,281	81,865	$12,807,407,000	$7,873,000,000	$20,680,407,000
City of Knoxville	173,890	175,032	73,636	$14,305,463,000	$10,535,113,000	$24,840,576,000
Town of Farragut	20,676	17,719	7,136	$1,692,456,000	$986,948,000	$2,679,404,000
Total	**432,226**	**382,032**	**162,637**	**$28,805,326,000**	**$19,395,061,000**	**$48,200,387,000**

Source: HAZUS MR5, KGIS

Table 3.32 provides the building count total for each county and city in the planning area broken out by building usage types (residential, commercial, industrial, agricultural, religious, government, and education). This data is supplied by HAZUS- MH MR 5 and is broken down into jurisdictions according to available census blocks.

Table 3.32 Building Counts by Usage Type

Jurisdiction	Residential	Commercial	Industrial	Agricultural	Religious	Government	Education	Total
Knox County (Unincorporated)	76,647	3,237	1,197	303	354	26	101	81,865
City of Knoxville	65,918	5,459	1,185	201	584	115	174	73,636
Town of Farragut	6,587	388	76	22	48	2	13	7,136
Total	**149,152**	**9,084**	**2,458**	**526**	**986**	**143**	**288**	**162,637**

Source: HAZUS MR5, KGIS

Critical Facilities and Infrastructure

A critical facility may be defined as one that is essential in providing utility or direction either during the response to an emergency or during the recovery operation. Table 3.33 gives examples of essential facilities, high potential loss facilities and transportation and lifelines as they are defined for purposes of this analysis.

Table 3.33 Critical Facilities, Definitions and Examples

Essential Facilities	High Potential Loss Facilities	Transportation and Lifelines
Hospitals and other medical facilities	Power plants	Highways, bridges, and tunnels
Police stations	Dams and levees	Railroads and facilities
Fire stations	Military installations	Airports
Emergency operations centers	Hazardous material sites	Water treatment facilities
	Schools	Natural gas, facilities and pipelines
	Shelters	Communications facilities
	Day care centers	
	Nursing homes	
	Main government buildings	

Source: FEMA HAZUS-MH MR5

Table 3.34 is an inventory of critical facilities and infrastructure (based on available data) in Knox County.

Table 3.34 Inventory of Critical Facilities and Infrastructure by Jurisdiction

Faculty	City of Knoxville	Town of Farragut	Knox County Unincorporated	Total
Airports	1	0	0	0
Bus Facilities	5	0	2	2
Communication Facilities	23	0	9	9
Electric Power Facilities	4	0	0	0
Fire Stations	1	0	3	3
Hazmat Locations	50	0	35	35
Potable Water Facilities	1	0	5	5
Police Stations	10	0	0	0
Hospitals	6	0	1	1
Natural Gas Facilities	1	0	0	0
Oil Facilities	2	0	0	0
Port Facilities	9	0	1	1
Schools	69	7	48	55
Waste Water Facilities	3	0	11	11
Totals	**185**	**7**	**115**	**122**

Sources: HAZUS-MH MR 5

Figure 3.45 through Figure 3.48 on the following pages show the location of critical facilities and bridges in Knox County. Figure 3.45 provides locations of the critical facilities in the entire planning area. Figure 3.46 and Figure 3.47 provide more detailed locations of the critical facilities in the City of Knoxville and the Town of Farragut. Lastly, Figure 3.48 provides the locations of bridges in Knox County.

Figure 3.45. **Knox County Critical Facilities**

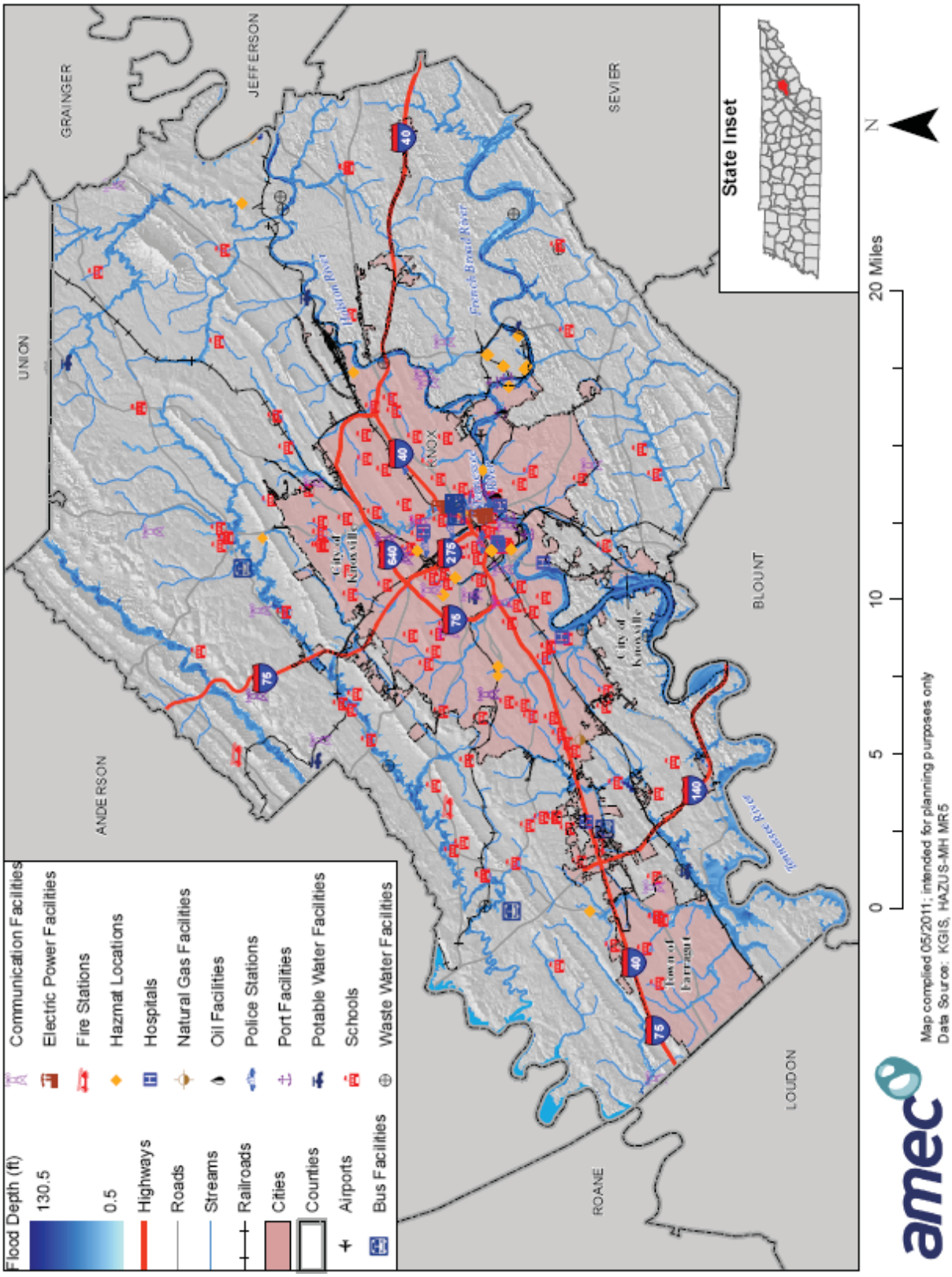


Figure 3.46. **City of Knoxville Critical Facilities**

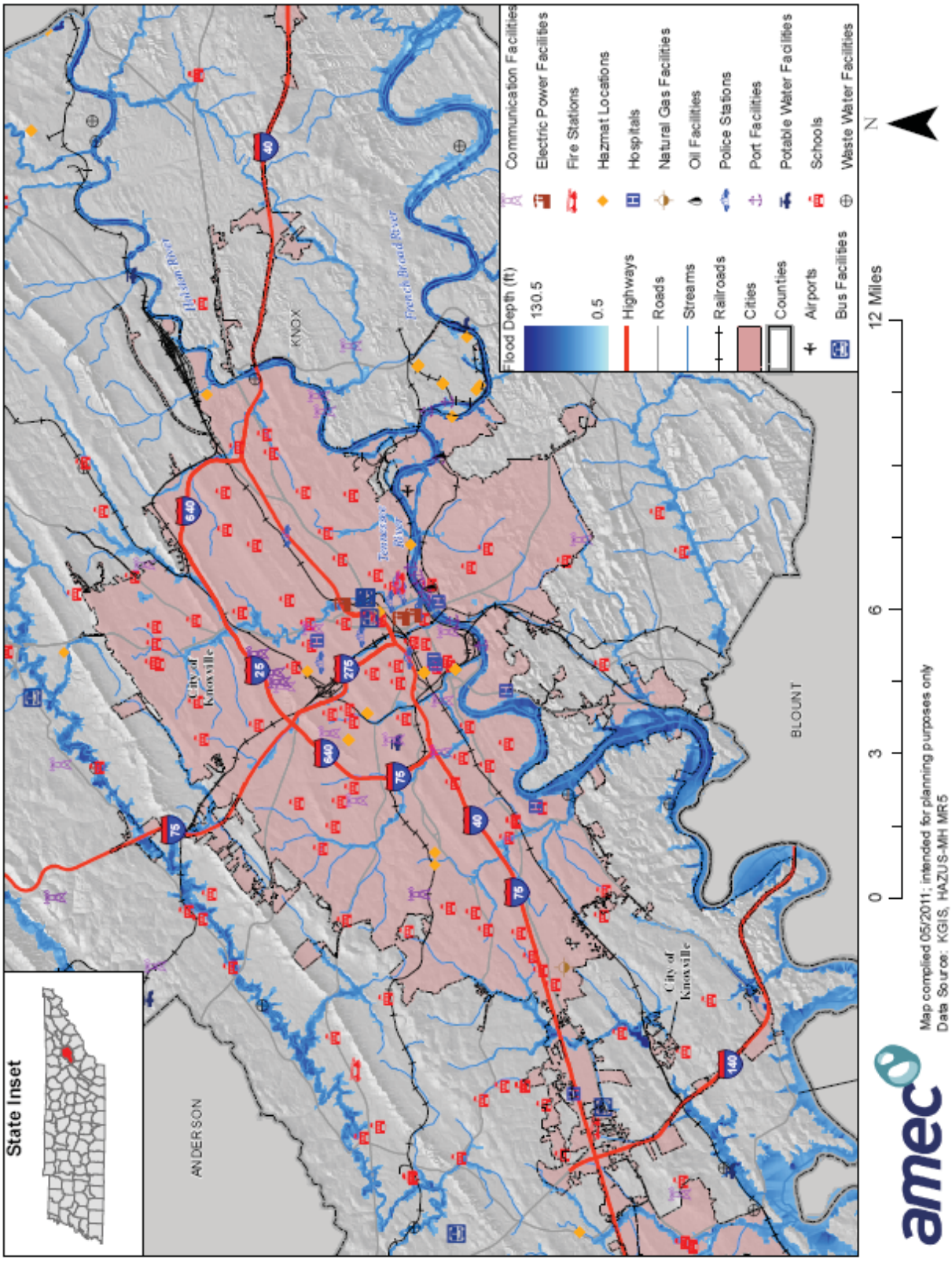


Figure 3.47. **Town of Farragut Critical Facilities**

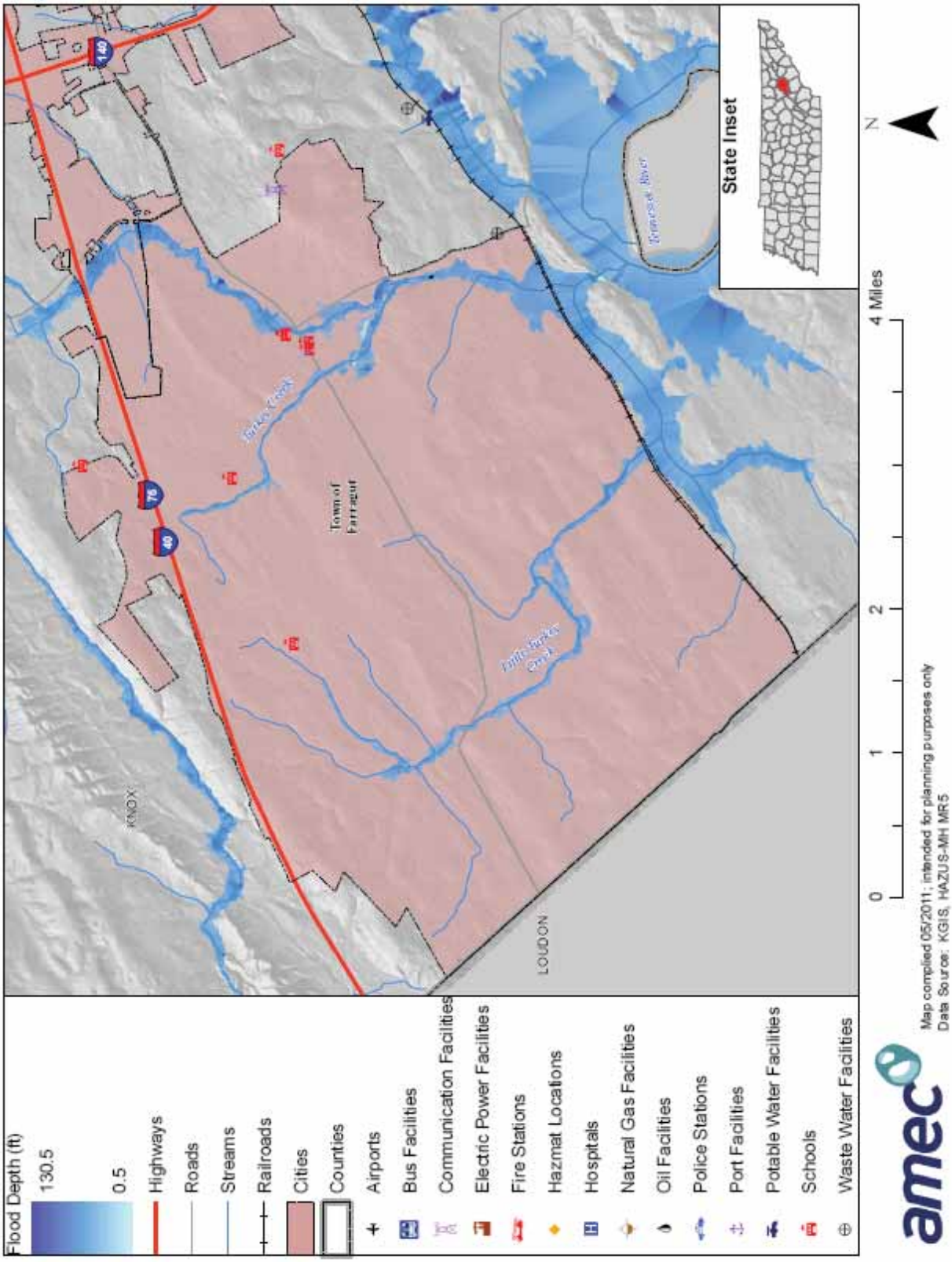
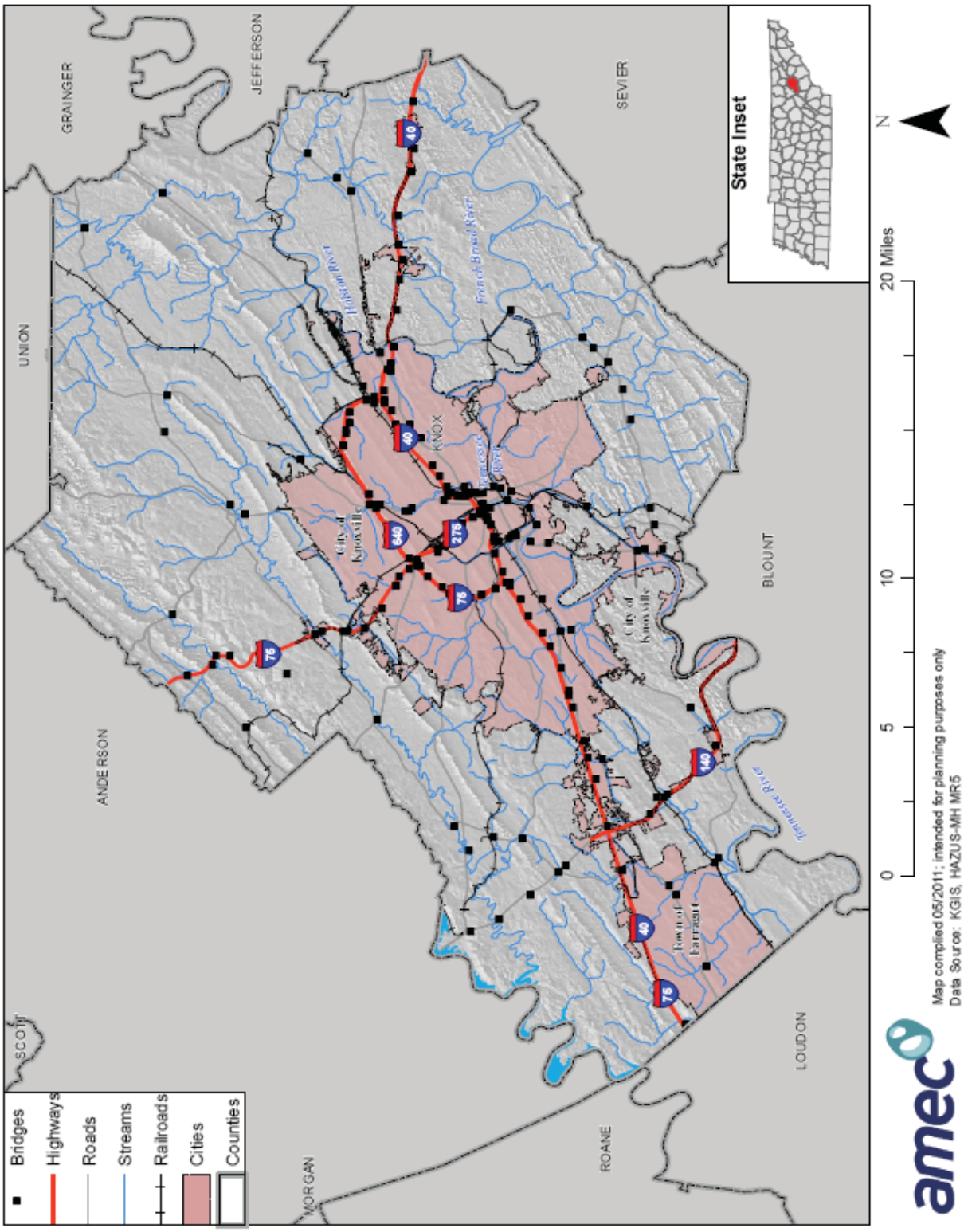


Figure 3.48. **Knox County Bridges**



Other Assets

Assessing the vulnerability of Knox County to disaster also involves inventorying the natural, historic, cultural, and economic assets of the area. This is important for the following reasons:

- The County may decide that these types of resources warrant a greater degree of protection due to their unique and irreplaceable nature and contribution to the overall economy.
- If these resources are impacted by a disaster, knowing about them ahead of time allows for more prudent care in the immediate aftermath, when the potential for additional impacts is higher.
- The rules for reconstruction, restoration, rehabilitation, and/or replacement are often different for these types of designated resources.
- Natural resources can have beneficial functions that reduce the impacts of natural hazards, such as wetlands and riparian habitat, which help absorb and attenuate floodwaters.
- Losses to economic assets (e.g., major employers or primary economic sectors) could have severe impacts on a community and its ability to recover from disaster.

In Knox County, specific assets include the following:

- Natural Resources:
  - There are 58 known species in Knox County with state endangered, threatened, or special concern status. The list of such species includes 10 invertebrate species, 5 nonvascular plants, 1 other type, 24 vascular plants, and 10 vertebrate animals. For the list of species and their status, go to http://state.tn.us/environment/na/data.shtml.
  - Over 6,167 acres of park and recreation space, including 27 recreation centers, six senior citizen centers, 13 public golf courses and more than 60 miles of greenway and walking trails.
- Cultural Resources:
  - Knoxville's Zoological Gardens and Ijams Nature Center
  - Nationally-ranked University of Tennessee varsity teams, Knoxville Ice Bears (minor league hockey team) and the Women's Basketball Hall of Fame
  - Knoxville Symphony, Knoxville Opera Company, and the Tennessee Children's Dance Ensemble are in the City as well as choral groups, dance companies, and 11 performance theatres promoting the arts.
- Economic Assets (major employers and national leaders in their industry)
  - Scripps Television Networks
  - Sysco Corporation's regional warehouse and distribution center

  - Clayton Homes
  - Brunswick Corporation
  - Green Mountain Coffee
  - Bush Brothers Beans
  - Pilot Corporation
  - Ruby Tuesday
- Historic resources: There are 50 properties on the National Register of Historic Places in Knox County. There are 48 properties in the City of Knoxville, one in the Concord area, and one in the Mascott area. For a specific listing of properties and additional details, go to www.nationalregisterofhistoricplaces.com/tn/state.html.

3.3.3 Vulnerability by Hazard

In order to focus on the most critical hazards, those assigned a level of high or moderate planning significance were given more extensive attention in the remainder of this analysis (e.g., quantitative analysis or loss estimation where available), while those with a low planning significance were addressed in more general or qualitative ways.

Dam Failure Vulnerability

Overview

Planning Significance: Low.

Dam or levee failure is typically an additional or secondary impact of another disaster such as flooding or earthquake. The impacts to the County and its municipalities from a dam failure would be similar in some cases to those associated with flood events (see the flood hazard vulnerability analysis and discussion). The biggest difference is that a catastrophic dam failure has the potential to result in greater destruction due to the potential speed of onset and greater depth, extent, and velocity of flooding. Another difference is that dam failures could flood areas outside of mapped flood hazards.

Knox County has 1 state regulated dam, Victor Ashe Dam in the city limits of Knoxville. There are 7 TVA dams upstream of Knox County that could impact the planning area in the event of failure.

Potential Losses to Existing Development

The participating jurisdictions and TVA are concerned about Homeland Security issues and choose not to publish dam inundation maps or dam failure results in this public document.

Future Development

Future development located downstream from dams in floodplains or inundation zones would increase vulnerability to this hazard. Since Knox County jurisdictions are

experiencing growth, consideration should be given to adoption of dam breach inundation zoning ordinances so that future development is not placed in areas vulnerable to dam inundation.

Drought Vulnerability

Overview

Planning Significance: Low.

Negative impacts of drought are primarily economic and environmental. Reduction in agricultural production is one of the most costly impacts of drought. Over 25 percent of the land area of Knox County is used for agricultural purposes, mostly in the unincorporated county. In addition to potential agricultural impacts, energy production is reduced for the hydroelectric plants that provide much of the power to the planning area. When this occurs, power providers must purchase additional power from other sources, which translates to higher costs to the consumer. Water supplies for local communities can also be threatened and soil erosion, dust, and wildfire hazard can all be exacerbated by drought conditions.

Potential Losses to Existing Development

Water treatment and distribution facilities could be affected during periods of prolonged drought and customers may be requested to limit water consumption.

To determine the potential losses that could be associated with loss of water during a drought affecting the water supply, loss of use estimates for utilities were obtained from FEMA's *BCA Reference Guide, 2009* which provides guidance on benefit-cost analysis of hazard mitigation projects. The loss of use estimate for loss of water supply is $93 per day per person.

Table 3.35 provides the loss of use estimates if water supply was lost for the jurisdictions in Knox County.

Table 3.35 Economic Damage Estimates for Loss of Water Supply

Jurisdiction	Population	Loss of Water Estimate ($93 per person per day)
Knox County (Unincorporated)	237,660	$22,102,380
City of Knoxville	173,890	$16,171,770
Town of Farragut	20,676	$1,922,868
Total	**432,226**	$40,197,018

Source: Population from 2010 Census, FEMA BCA Reference Guide

Another impact of drought would be to agricultural production in the county. Areas associated with agricultural use are vulnerable to drought conditions which could result in a decrease in crop production or a decrease in available grazing area for livestock. According to the ten-year period for which data is available from USDA's Risk Management Agency, (see previous occurrences section under drought profile in section 3.2.2) the average amount of annual claims paid for crop damage as a result of drought in Knox County was $3,224. The HMPC realizes that USDA claims only represent a portion of the actual damages. In 2010, 82 percent of insurable crops were insured in Knox County.

Aside from agricultural impacts, other losses related to drought include increased costs of fire suppression, damage to roads and structural foundations due to the shrink dynamic of expansive soils during excessively dry conditions, and loss of energy production from the hydroelectric plants that provide much of the electricity to the planning area.

Future Development

As population grows, demand for water increases for household, commercial, industrial, recreational, and agricultural uses. Population has increased and currently new development is on the rise. Future growth and development will increase the negative impact of drought in the planning area.

Earthquake Vulnerability

Overview

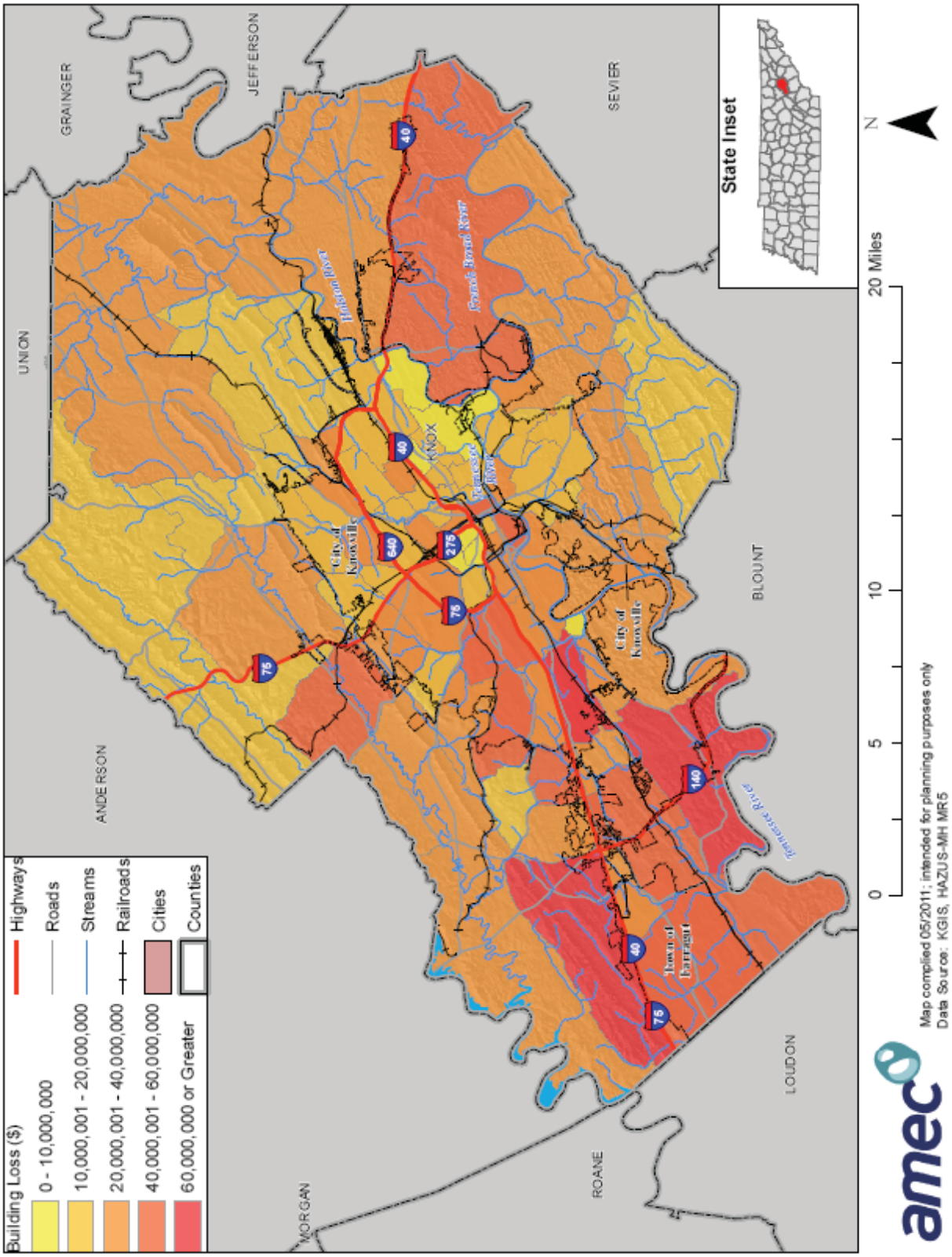
Planning Significance: Medium

As discussed in the Hazard Profile section, the Knox County planning area has fairly frequent low magnitude earthquakes that cause very little damage. However, a more damaging event is possible within the next 100 years. To provide useful information for planning purposes, a worst-case 2,500-year probabilistic, 7.5 magnitude scenario was considered for the vulnerability analysis. In analysis of a worst-case, probabilistic, 2,500 year event, HAZUS estimates that about 37,341 buildings in the planning area would be at least moderately damaged. This is over 23.00 % of the total number of buildings in the region. There are an estimated 2,350 buildings that would be damaged beyond repair. The greatest losses would occur in the City of Knoxville with an estimated $1.4 million in building damages, nearly .5 million in contents damage, and 2,557 displaced households. Detailed estimates for all jurisdictions are provided in the next sections.

Potential Losses to Existing Development

HAZUS MR5 was used to determine potential losses to existing development. The estimated losses are displayed in the map in Figure 3.49.

Figure 3.49. **Estimated Building Losses-2,500 Year Earthquake Event, Knox County**



Although there are pockets of concentrated damages in the Town of Farragut and the unincorporated county, the building losses would be highest in the City of Knoxville, mainly because of the geographic area covered by city limits and the building density. Table 3.36 provides details of building losses for each jurisdiction. The HAZUS loss estimates are provided by census tract, not jurisdictional boundary. Therefore, estimates for each jurisdiction were determined by analyzing the spatial HAZUS loss estimates. For losses in census tracts that cross jurisdictional boundaries, a determination was made regarding which jurisdiction to attribute those losses to.

Table 3.36 Estimated Building Losses-2,500 Year Earthquake Event, Knox County

Jurisdiction	Cost Structural Damage ($)	Contents Damage ($)	Inventory Loss ($)	Total
Knox County (Unincorporated)	$623,152,630	$197,649,250	$10,795,140	$831,597,020
City of Knoxville	$1,442,986,480	$469,909,215	$18,285,890	$1,931,181,585
Town of Farragut	$87,702,390	$27,497,455	$398,960	$115,598,805
Total	**$2,153,841,500**	**$695,055,920**	**$29,479,990**	**$2,878,377,410**

Source: HAZUS-MH MR5

According to this analysis, the planning area would have 7.5% damage to the total building exposure value in the planning area.

Table 3.37 Earthquake Loss Ratio--2,500 Year Earthquake Event

Jurisdiction	Building Exposure ($)	Structural Damage ($)	Loss Ratio (%)
Knox County (Unincorporated)	$12,807,407,000	$623,152,630	5%
City of Knoxville	$14,305,463,000	$1,442,986,480	10.10%
Town of Farragut	$1,692,456,000	$87,702,390	5.20%
Total	$28,805,326,000	$2,153,841,500	7.50%

Source: HAZUS-MH MR5

The table that follows provides information on displaced households and short-term shelter needs from the 2,500-year probabilistic event.

Table 3.38 Displaced Households and Shelter Needs—2,500 Year Earthquake Event

Jurisdiction	Displaced Households	Short Term Shelter Needs
Knox County (Unincorporated)	480	287
City of Knoxville	2,557	1,836
Town of Farragut	53	28
Total	3,090	2,151

Source: HAZUS-MH MR5

Future Development

Future development is not expected to increase the risk other than contributing to the overall exposure of what can become damaged as a result of an unlikely event.

Expansive Soils Vulnerability

Overview

Planning Significance: Low

According to the USGS “Swelling Clays Map of the Conterminous United States”, Knox County is located in an area underlain by soils with little to no clays with swelling potential.

Potential Losses to Existing Development

Damages to existing development are largely isolated incidents and affected property owners make necessary repairs.

Future Development

Sidewalks, roads, patios, and other large concrete or asphalt developments are particularly vulnerable to cracking due to the effects of the shrink-swell cycle with expansive soils. However, only small sections within the planning area have expansive soils.

Extreme Temperatures Vulnerability

Overview

Planning Significance: High.

The primary concern with this hazard is the potential health impacts, though economic impacts in the agricultural sector are also an issue. Those at greatest risk for heat-related illness include infants and children up to four years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications.. Individuals below the federal poverty level also may also be at increased risk to the impacts of extreme temperatures in cases where air conditioning and/or

heating are not affordable. Those over 65 are also considered to be at greater risk to extreme cold due to issues with poor circulation and the inability to regulate body temperature in some elderly people.

Based on information from the 2005-2009 American Community Survey 5-Year Estimates, Table 3.39 compares the percentage of persons over age 65, below age 5, and the percentage of persons below the federal poverty level in the participating jurisdictions to state and national averages. The Town of Farragut has the highest percentage of residents over age 65, at 14 percent. The unincorporated county has the highest percentage of residents under 5, at 6.3 percent, and the City of Knoxville has the highest percentage of population below the poverty level, at 25 percent.

Table 3.39 Population over age 65, Under 5 and Below the Poverty Level

Jurisdiction	# Age 65 and Over	% Age 65 and Over	# Age Under 5	% Age Under 5	% Individuals Below Poverty Level
Knox County (unincorporated)	27,419	12.4	13,900	6.3	Not available for this geography
City of Knoxville	23,944	13.1	11,075	6.1	25.0
Town of Farragut	2,824	14	1,215	6.0	2.7
Total Knox County	54,187	12.8	26,190	6.2	14.7

Source: 2005-2009 American Community Survey 5-Year Estimates, U.S. Census Bureau, http://factfinder.census.gov;

Potential Losses to Existing Development

Extreme temperatures normally do not impact structures and it is difficult to identify specific hazard areas. Heavy trucking can increase wear and tear on roadways during periods of extreme heat though the cost of these impacts is difficult to quantify. Stress on livestock and reductions in crop yields are also typical impacts of extended periods of high temperatures.

The power generation and transmission facilities and infrastructure are vulnerable to failure during periods of extreme heat due to an increased use of electricity to power air conditioning. If power failure occurs, occupants of nursing homes may be at increased risk if there is no alternate power source. According to the Tennessee Care Planning Council (http://www.caretennessee.org/index.htm), there are 16 long-term, nursing, and Medicare rehabilitation facilities in Knox County. If these facilities lost power, the special needs population would be at increased risk as would other elderly persons in private residences. There is no data available to estimate potential dollar losses as a result of power failure during extreme temperature events.

Future Development

In general, a growing population increases the number of people vulnerable to extreme temperature events. New development increases the strain on the power grid during extreme heat periods. Currently, population and development trends in Knox County are increasing, thereby increasing vulnerability to this hazard in the short term.

Flood Vulnerability

Overview

Planning Significance: High. Flood damage estimates for a one-percent annual chance (100-year) riverine flood scenario were generated utilizing FEMA's HAZUS-MH MR5 loss estimation software. The DFIRM floodplain depth grid was generated using the hydrology and hydraulic models and the 2007/2010 Digital Elevation Models provided by KGIS. The DFIRM depth grid was integrated into FEMA's HAZUS-MH MR5 software to generate maps as well as loss estimates. Integration of the DFIRM data provides more comprehensive data (i.e. data includes more stream reaches) than if the floodplains were generated out of HAZUS without the DFIRM data.

According to the loss estimates generated by the HAZUS/DFIRM analysis provided in Table 3.40, the unincorporated county would have the highest economic losses in terms of number, dollar loss, and building loss ratio as well as the most displaced population and population needing shelter.

Table 3.40 One Percent Annual Chance Flood Loss Summary, Knox County

Jurisdiction	# of Damaged Buildings	Building Damage ($)	Building Loss Ratio	Displaced Population	Population Needing Shelter
Knox County (unincorporated)	674	$119,820,000	1%	6,276	3,759
City of Knoxville	104	$58,244,000	0.40%	2,251	1,303
Town of Farragut	8	$4,585,000	0.30%	225	51
Total	**786**	**$182,649,000**	**0.60%**	**8,752**	**5,113**

This analysis does not take into account damages caused by flashflooding or sinkhole flooding. Damages caused by these events are difficult to estimate due to the many variables such as duration and intensity of rainfall.

Potential Losses to Existing Development

Additional detailed descriptions of potential losses to existing development as a result of a 100-year riverine flood will include analyses of estimated population displaced, numbers and types of buildings impacted and economic losses.

Estimated Population Displaced

Potential losses to the planning area were estimated based on the location of population and building assets in relation to the one percent annual chance flood. Population displaced was aggregated from HAZUS data at the census-block level, the most detailed information available from the U.S. Census. Table 3.41 provides the numbers of people that would be displaced and those that would need shelter in each city. According to this analysis, over 8,752 people in the planning area are at risk of being

displaced if a 100-year flood impacted their area. The jurisdiction with the potential for the most displaced people is the unincorporated county with 6,275 displaced people. Figure 3.50 shows the locations of populations in the planning area by census block that could be displaced by a one percent annual chance flood. The map is displayed this way first since the floodplain is so narrow that it is difficult to see the impacted areas. Figure 3.51 that follows, displays this same information with the census block clipped to the 100-year floodplain since that is the spatial area in from which displacement would occur. Finally, Figure 3.52 and Figure 3.53 display the displaced population for the City of Knoxville and the Town of Farragut, clipped to the floodplain.

Table 3.41 One Percent Annual Chance Flood, Displaced Population, Knox County

Jurisdiction	Displaced Population	Short Term Shelter Needs
Knox County (unincorporated)	6,276	3,759
City of Knoxville	2,251	1,303
Town of Farragut	225	51
Total	**8,752**	**5,113**

Figure 3.50. **Estimated Population Displaced by 100-Year Flood in Knox County, by Census Block**

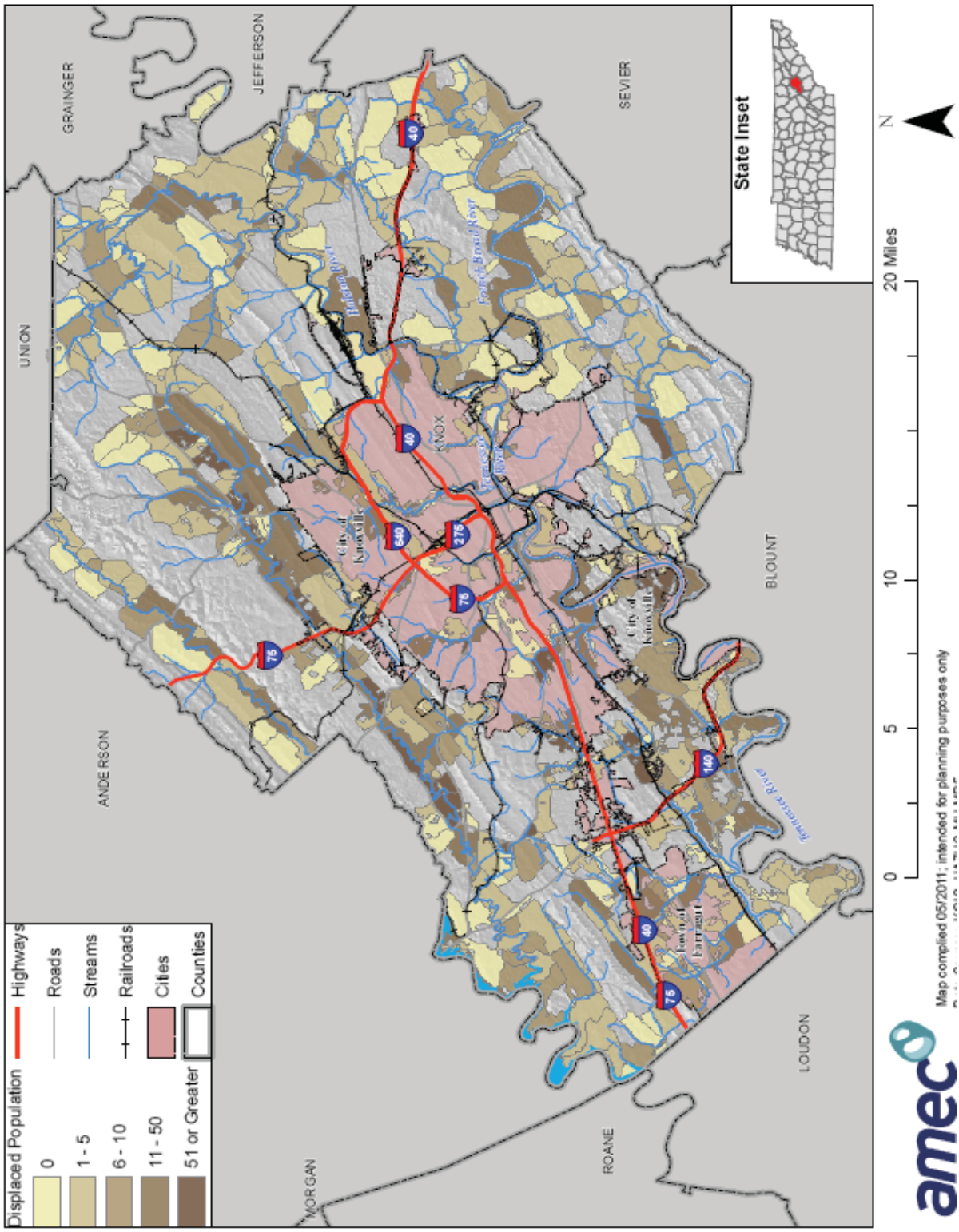


Figure 3.51. **Estimated Population Displaced by 100-Year Flood in Knox County, Clipped to Floodplain**

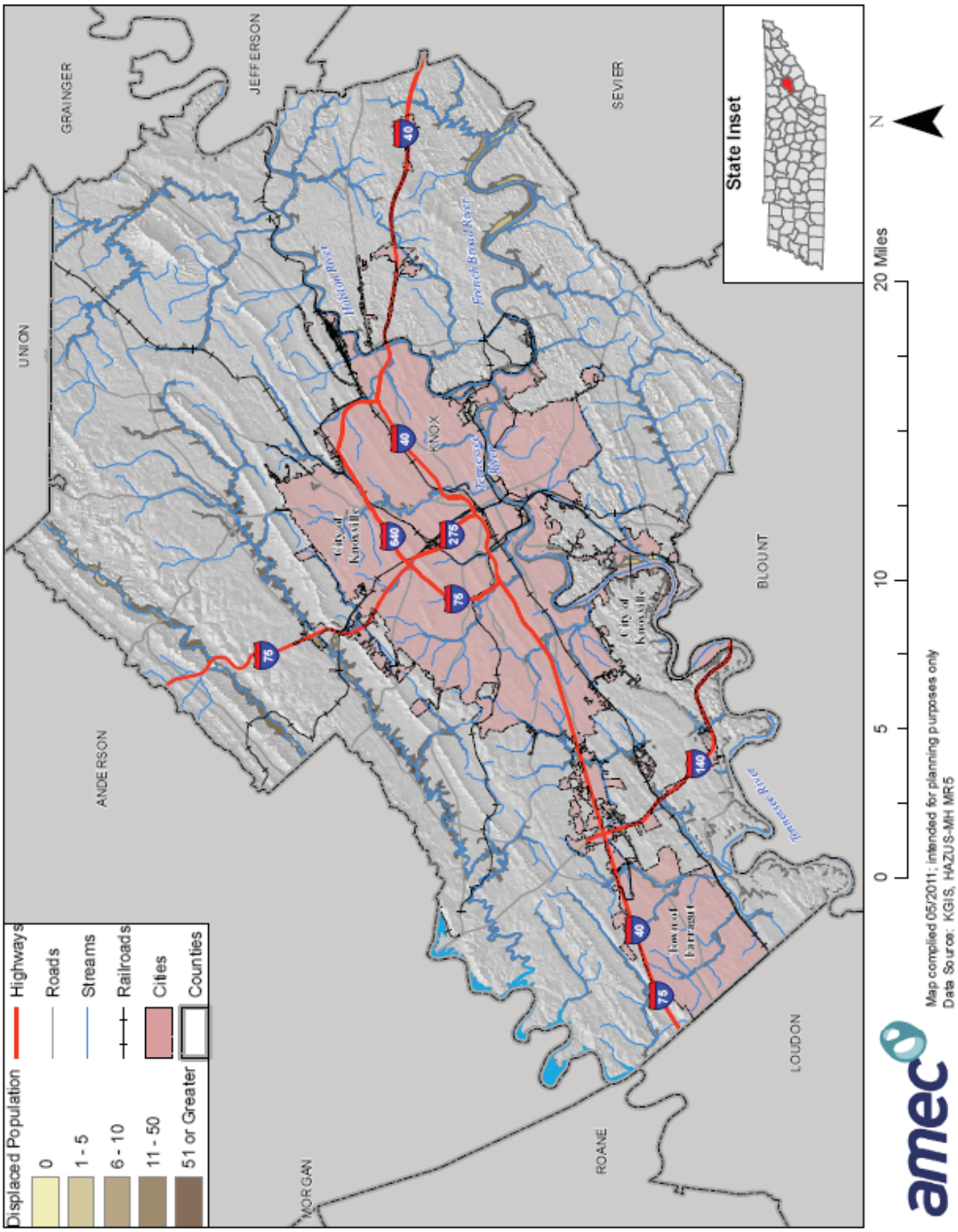


Figure 3.52. **Estimated Population Displaced by 100-Year Flood in the City of Knoxville, Clipped to Floodplain**

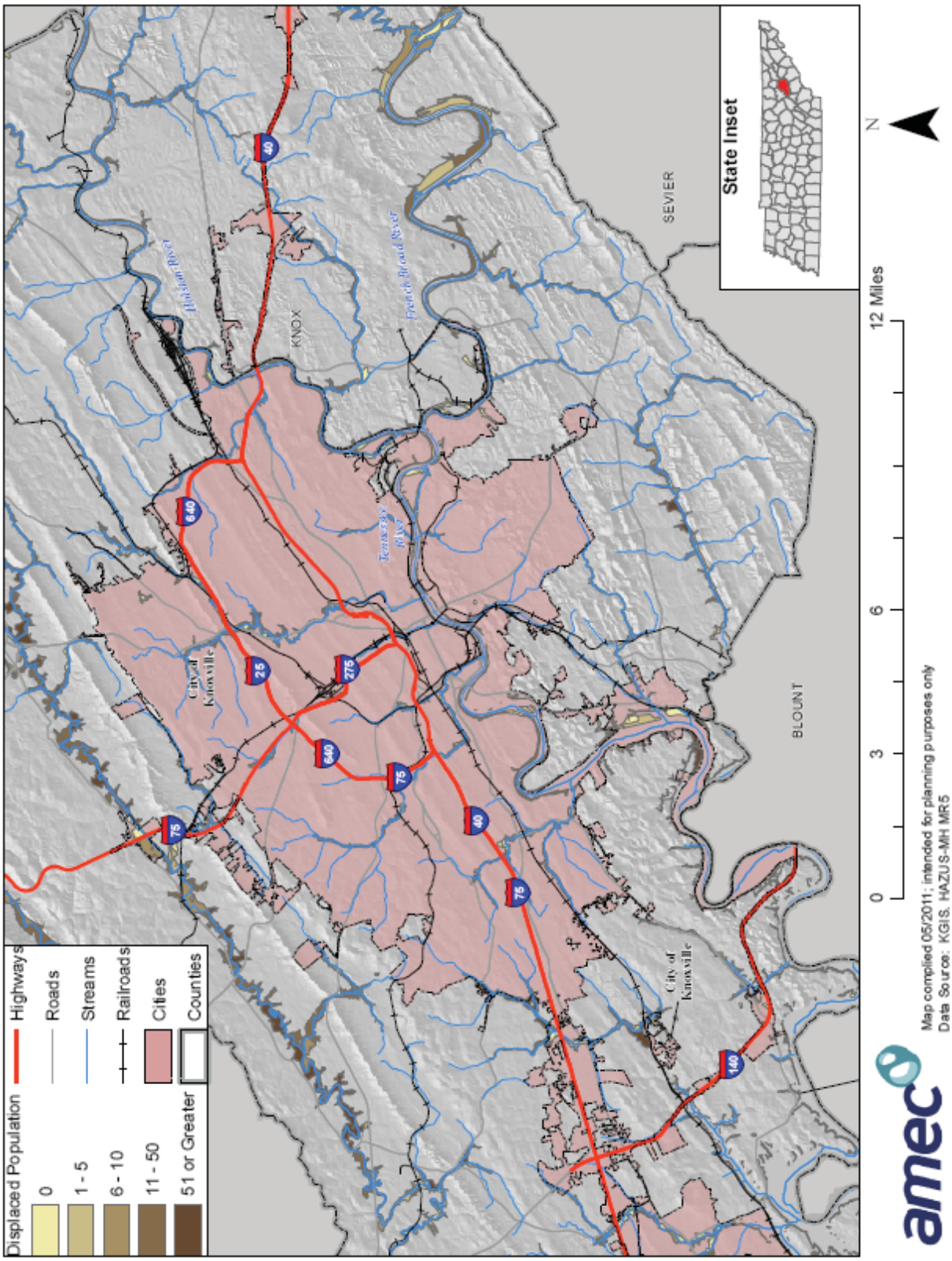
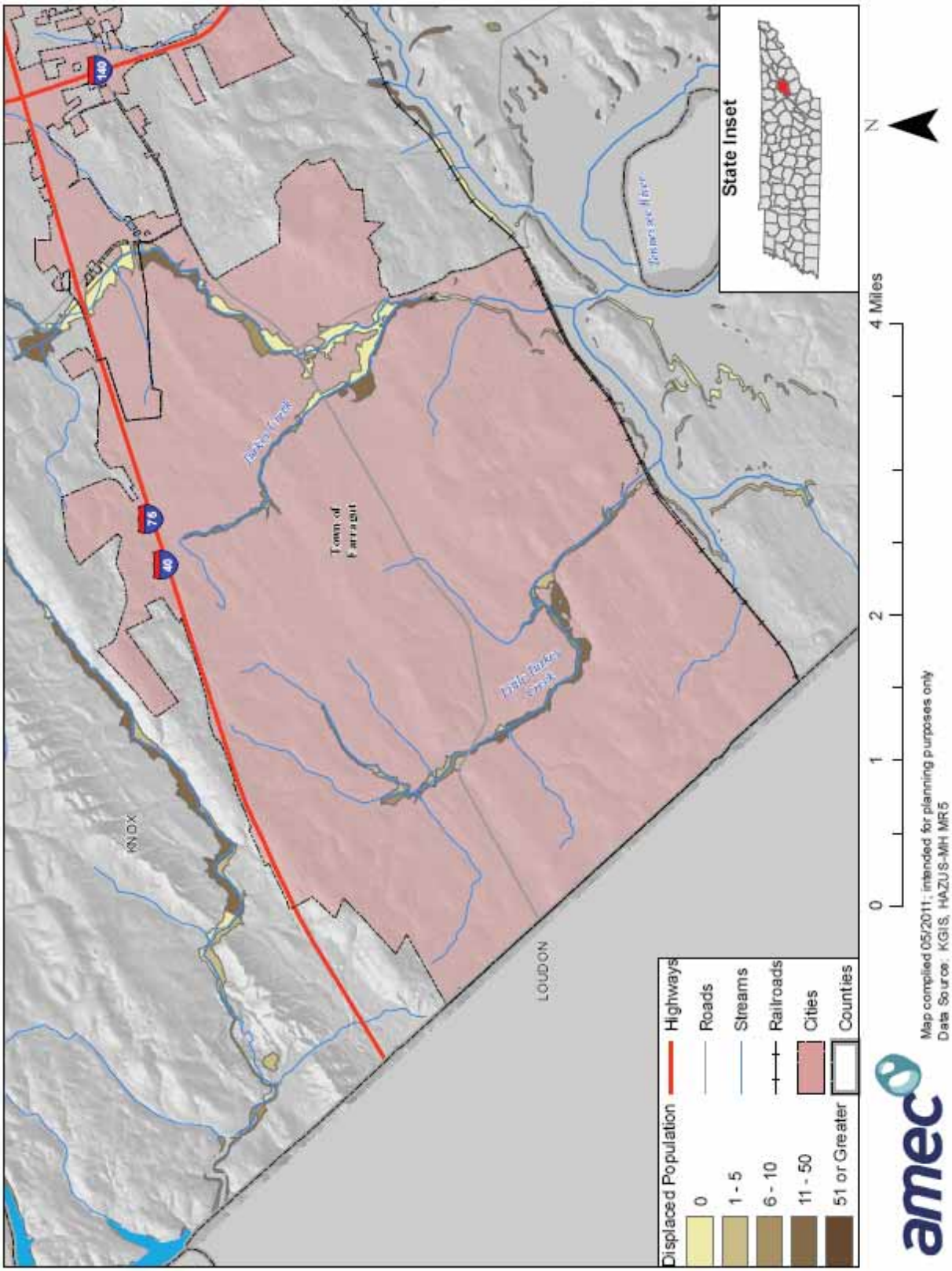


Figure 3.53. **Estimated Population Displaced by 100-Year Flood in the Town of Farragut, Clipped to Floodplain**



Building Losses (counts and types of damaged buildings, and economic losses)

To estimate economic losses due to a 1 percent flood chance, HAZUS provides reports on the number and types of buildings impacted, estimates of the building repair costs, and the associated loss of building contents and business inventory as well as a building damage loss ratio. For each jurisdiction in the planning area, this section provides three sets of analysis reports in tabular format.

- **Building Counts and Types of Damaged Buildings:** This provides the total number of buildings expected to be impacted and is further broken down by impacted usage types. The damaged building counts generated by HAZUS-MH are susceptible to rounding errors and are likely the weakest output of the model due to the use of census blocks for analysis.
- **Economic Losses:** Building damage can result in additional losses to a community as a whole by restricting a building's ability to function properly. Income loss data accounts for business interruption and rental income losses as well as the resources associated with damage repair and job and housing losses. These losses are calculated by HAZUS using a methodology based on the building damage estimates. The building valuations used in HAZUS-MH MR4 are updated to R.S. Means 2006 and commercial data is updated to Dun & Bradstreet 2006. There could be errors and inadequacies associated with the hydrologic and hydraulic modeling of the HAZUS-MH model. Flood damage is directly related to the depth of the potential flooding. For example, a two-foot flood generally results in about 20% damage to the structure (which translates to 20% of the structure's replacement value). The planning area's building inventory loss estimates (which are linked to census block geography) were separated out by jurisdiction, according to the HAZUS-MH analysis results, to illustrate how the potential for loss varies across the planning area.
- **Building Damage Loss Ratio**: This is an indication of the community's ability to recover after an event. Building Damage Loss Ratio percent is calculated by taking the Building Structural Damage divided by Building Structural Value and then multiplying by 100. Loss ratios exceeding 10% are considered significant by FEMA.

Table 3.42 Counts and Types of Damaged Buildings (100-Year Flood)

Jurisdiction	Residential	Commercial	Industrial	Agricultural	Religion	Government	Education	Total
Knox County (unincorporated)	673	0	1	0	0	0	0	674
City of Knoxville	93	11	0	0	0	0	0	104
Town of Farragut	2	6	0	0	0	0	0	8
Total	**768**	**17**	**1**	**0**	**0**	**0**	**0**	**786**

Table 3.43 Economic Losses (100-Year Flood)

Jurisdiction	Building Damage ($)	Contents Damage ($)	Inventory Loss ($)	Relocation Loss ($)	Capital Related Loss ($)	Wage Loss ($)	Rental Income Loss ($)	Total ($)
Knox County (unincorporated)	$119,820,000	$119,288,000	$8,386,000	$141,000	$149,000	$1,408,000	$30,000	$249,222,000
City of Knoxville	$58,244,000	$111,108,000	$5,856,000	$121,000	$542,000	$1,614,000	$81,000	$177,566,000
Town of Farragut	$4,585,000	$10,437,000	$323,000	$11,000	$83,000	$152,000	$7,000	$15,598,000
Total	$182,649,000	$240,833,000	$14,565,000	$273,000	$774,000	$3,174,000	$118,000	$442,386,000

Table 3.44 Building Damage Loss Ratio (100-Year Flood)

Jurisdiction	Building Exposure ($)	Building Damage ($)	Loss Ratio (%)
Knox County (unincorporated)	$12,807,407,000	$119,820,000	1%
City of Knoxville	$14,305,463,000	$58,244,000	0.40%
Town of Farragut	$1,692,456,000	$4,585,000	0.30%
Total	**$28,805,326,000**	**$182,649,000**	**0.60%**

Figure 3.54 through Figure 3.57 show the combined estimated losses to structures, contents, and other associated losses. The areas shaded darker green are those areas that would experience greater loss. Similar to the displaced population figures, the first county-wide figure displays the information with each full census block filled in. The remaining three figures display the information with the census block clipped to the floodplain for the county, then the City of Knoxville, and then the Town of Farragut.

Figure 3.54. **Estimated Financial Losses from 100-Year Flood in Knox County, Census Block**

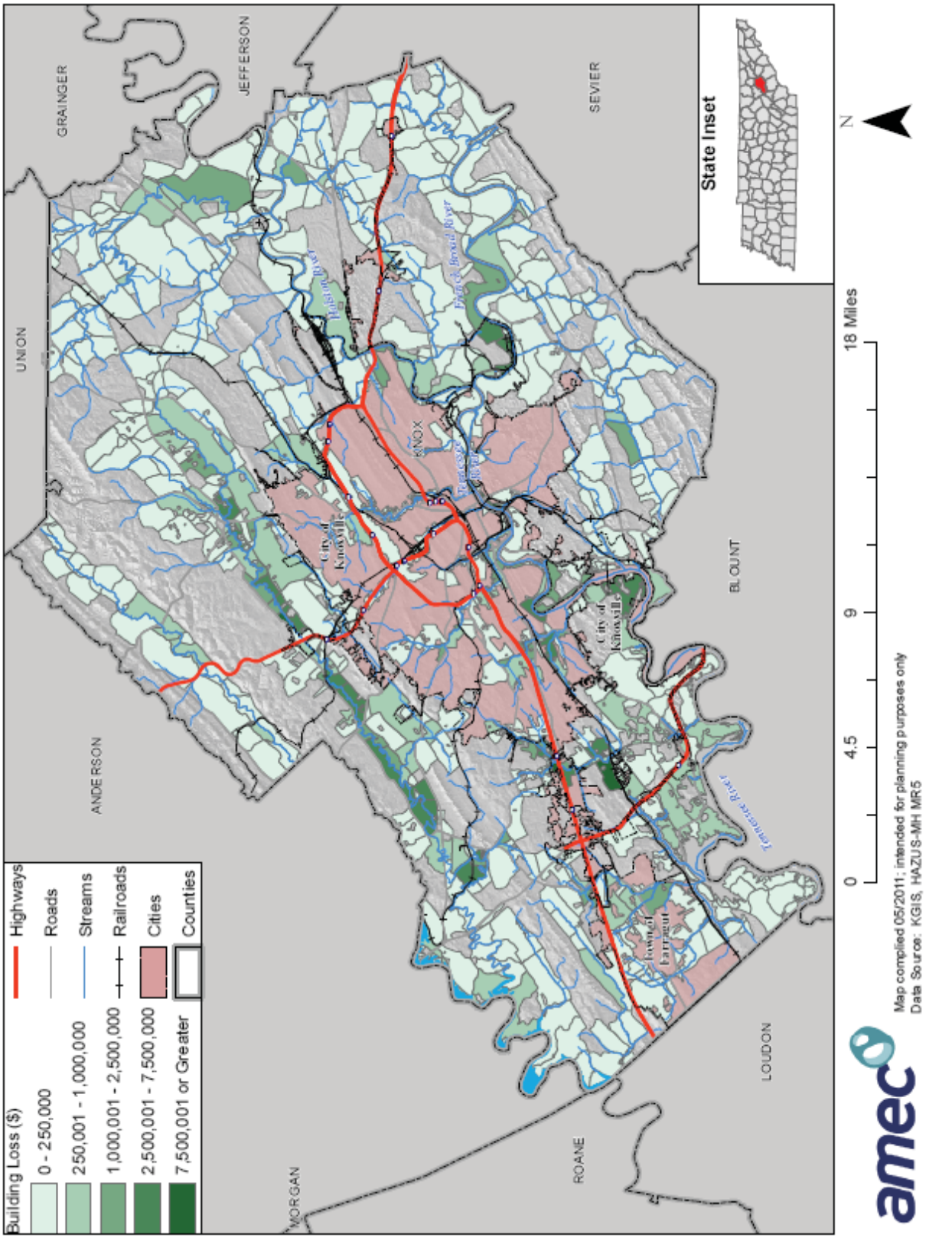


Figure 3.55. **Estimated Financial Losses from 100-Year Flood in Knox County, Clipped to Floodplain**

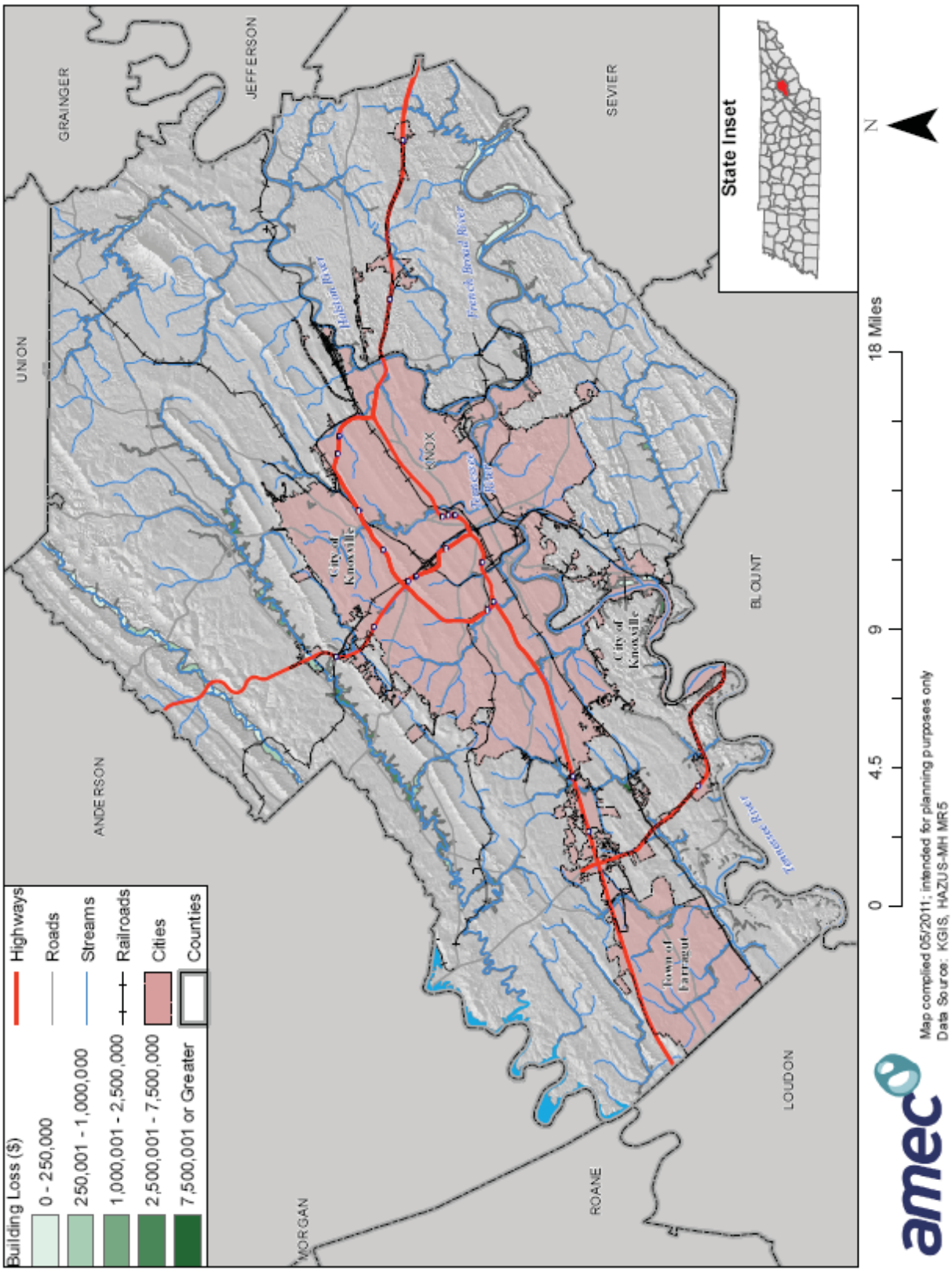


Figure 3.56. **Estimated Financial Losses from 100-Year Flood in the City of Knoxville, Clipped to Floodplain**

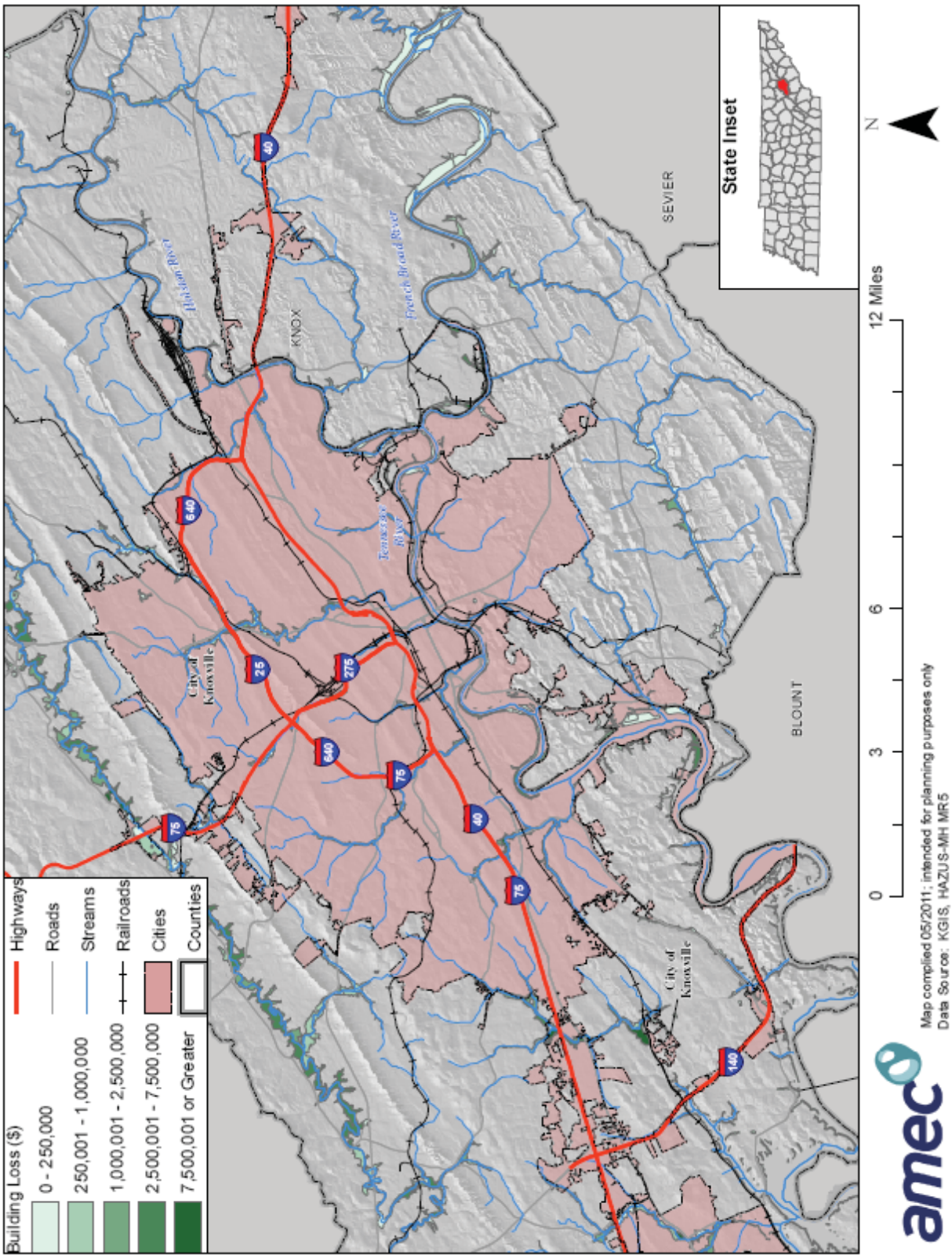
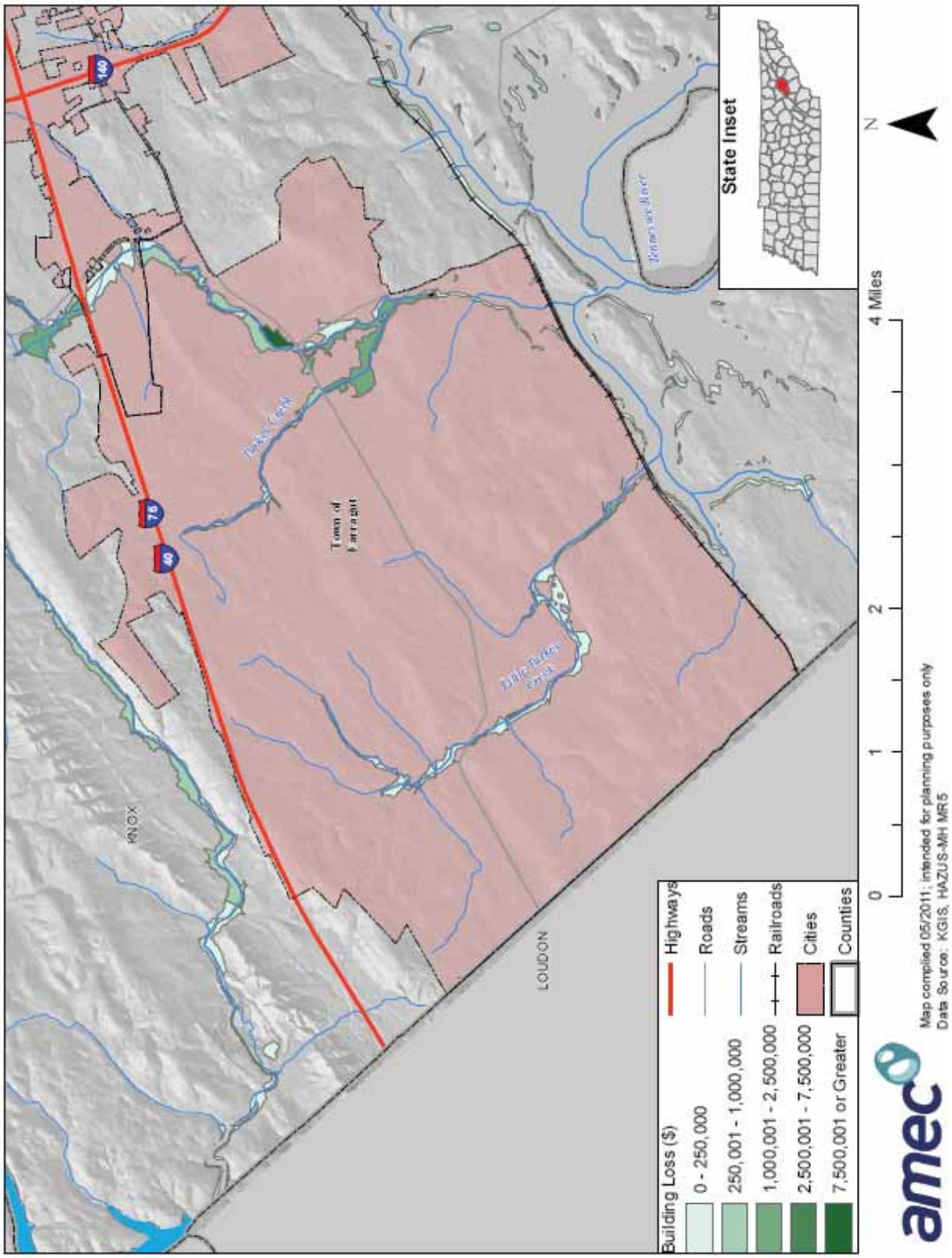


Figure 3.57. **Estimated Financial Losses from 100-Year Flood in Town of Farragut, Clipped to Floodplain**



Agricultural Impacts

In addition, USDA crop insurance claims as a result of flood and excessive moisture damage has averaged $10,656 per year from 2000 to 2009 and total $106,565 for the period.

Critical Facilities, Pipelines, and Power Infrastructure at Risk

Available critical facilities data was compared to the HAZUS generated 100-year floodplain to show the locations of critical facilities in relation to the floodplain. According to this analysis, there are several facilities within the floodplain. Table 3.45 provides the names and flood depths of the critical facilities determined to be in the floodplain Figure 3.45 through Figure 3.47 in Section 3.3.2 Community Assets, provide maps for each jurisdiction in the planning area showing the critical facilities in relation to the floodplain.

Table 3.45 Critical Facilities in the Floodplain in the Planning Area

Jurisdiction	Type	Flooded Critical Facility	Flood Elevation (ft)
Knox County (unincorporated)	Hazmat Location	Asarco Inc. Immel Mine	0.5
Knox County (unincorporated)	Port Facility	Burkhart Enterprises, Forks of the River	23.5
Knox County (unincorporated)	Potable Water Facilities	Luttrell-Blaine-Corryton WTP	10.4
Knox County (unincorporated)	School	Powell Middle School	2.6
Knox County (unincorporated)	School	Brickley Mccloud Elementary School	0.5
Knox County (unincorporated)	Waste Water Facility	Duncan Landing Devel. STP	0.5
Knox County (unincorporated)	Waste Water Facility	Hallsdale Powell Utility District	3.2
Knox County (unincorporated)	Waste Water Facility	KUB-Eastbridge STP	16.6
City of Knoxville	Communication Facility	WMEN 760	11.8
City of Knoxville	Communication Facility	WJXB 1240	2.6
City of Knoxville	Electric Power Facility	Knoxville Utilities Board	0.7
City of Knoxville	Hazmat Location	Sea Ray Boats	24.1
City of Knoxville	Oil Facility	Volunteer Asphalt Company	0.5
City of Knoxville	Port Facility	Star of Knoxville Riverboat Dock.	12.4
City of Knoxville	Port Facility	Regal Corp., Knoxville Terminal Wharf.	11.2
City of Knoxville	Port Facility	Southern States Asphalt, Knoxville Asphalt	8.9
City of Knoxville	Port Facility	Ron Conley Enterprises, Texaco Knoxville	9.5
City of Knoxville	Port Facility	Ron Conley Enterprises, Cargill Knoxville	4.1
City of Knoxville	Port Facility	Signal Mountain Cement Co., Knoxville Pu	10.6
City of Knoxville	Port Facility	Volunteer Asphalt Co., Knoxville Dock.	1.4
City of Knoxville	Port Facility	C. Reed Davis Contractors, Blount Avenue	7.5
City of Knoxville	Port Facility	Burkhart Enterprises, Knoxville Dock.	10.3
City of Knoxville	School	Sacred Heart Cathedral School	11.9
Town of Farragut	School	The Farragut Montessori School	1.1
Town of Farragut	School	Farragut High School	0.5

Scour Critical Bridges

A scour index is used to quantify the vulnerability of a bridge to structural damage during a flood due to undermining or displacement of bridge supports during increased river flow volumes. Bridges with a scour index between 1 and 3 are considered scour critical, which means their foundation elements are unstable for the observed or evaluated scour condition.

Based on information from the National Bridge Inventory database developed by the Federal Highway Administration, there are no scour critical bridges located in the planning area.

Future Development

Any future development in floodplains would increase risk in those areas. Since all jurisdictions in the planning area participate in the National Flood Insurance Program, enforcement of the floodplain management regulations will ensure mitigation of future construction in those areas. However, even if structures are mitigated, evacuation may still be necessary due to rising waters. In addition, floods that exceed mitigated levels may still cause damages.

Knox County has also addressed the issue of future development and vulnerability to sinkhole flooding through Section 8.5 of the Knox County Tennessee Stormwater Management Manual. This section contains regulations and policies for developments near sinkholes aimed at ensuring that future developments do not increase vulnerability of new or existing structures to sinkhole flooding.

Land Subsidence/Sinkholes Vulnerability

Overview

Planning Significance: Medium

According to the 1995 Investigation of Sinkhole Flooding Problems in Knoxville, Tennessee by Albert E. Ogden, approximately 15 percent of the City of Knoxville is built around or in sinkholes. Based on a review of the USGS map “Areas with Abundant Sinkholes in Knox County, Tennessee”, it appears that the sinkhole density is slightly less overall in the unincorporated county and the least dense in the Town of Farragut. However, sinkholes and areas underlain by dolomite and limestone bedrock that could develop into sinkholes are prevalent throughout the entire planning area.

Potential Losses to Existing Development

It is anticipated that losses to existing development will continue within the planning area where structures and infrastructure are constructed on or near sinkhole areas. To

estimate the number and value of structures in the planning area that are built on known sinkhole areas and therefore, potentially subject to damage in the event of sinkhole collapse, the USGS map, "Areas with Abundant Sinkholes in Knox County, Tennessee" was digitized and overlaid on the HAZUS MH MR5 building exposure data. Buildings with their centroid in the sinkhole areas were determined. Table 3.46 provides the results of this analysis.

Table 3.46 Building Counts and Values Over Known Sinkholes, Knox County

Jurisdiction	Building Counts								Total Value of Buildings Over Known Sinkholes
	Residential	Commercial	Industrial	Agricultural	Religion	Government	Education	Total	
Knox County (unincorporated)	4,280	170	56	13	22	0	6	4,547	$189,118,000
City of Knoxville	4,131	312	56	11	26	4	12	4,552	$858,603,000
Town of Farragut	716	13	2	2	2	0	1	736	$753,139,000
Total	**9,127**	**495**	**114**	**26**	**50**	**4**	**19**	**9,835**	**$1,800,860,000**

Future Development

Section 8.5 of the Knox County Tennessee Stormwater Management Manual contains regulations and policies for developments that are located near and/or drain to sinkholes.

Landslide Vulnerability

Overview

Planning Significance: Medium

According to the USGS National Atlas of the United States, all of Knox County has at least moderate susceptibility/low incidence to landslide. There are some small portions in the unincorporated county that are considered high susceptibility/moderate incidence.

Potential Losses to Existing Development

According to the Knoxville-Knox County Hillside and Ridgetop Protection Plan, 33 percent of Knox County has slope characteristics that exceed 15% slopes. This combined with several strips of land in the planning area that have high and moderate soil slippage potential equates to several areas throughout the county that are vulnerable to landslides. When vegetation is cleared and heavy machinery operates in areas prone to slide, damage can occur to existing development that is downslope from these activities. Data is not currently available to determine quantitative exposure and monetary loss estimates to infrastructure and development as a result of future

landslides. If this data becomes available, it will be incorporated in future updates to this plan.

Future Development

The City of Knoxville and Knox County recognize the threat of landslide to future development. In 2008, the Knoxville City Council and Knox County Commission asked 30 citizen representatives from a variety of interests, including foresters, engineers, landscape architects, realtors, developers, neighborhood and environmental advocates to begin studying the issues related to steep slope, hillside and ridgetop development and protection. This City-County Task Force worked for almost two and half years with MPC staff to develop the Knoxville-Knox County Hillside and Ridgetop Protection Plan. The plan was adopted with changes by MPC commission on December 9th, 2010. The plan has been forwarded to City Council and County Commission with recommendations for adoption.

If adopted, the Hillside and Ridgetop Protection Plan will be an element of the Knoxville Knox County General Plan, representing policies to provide for protection of hillside and ridgetop areas, while still allowing for development. The proposals for incentives, development guidelines, and land use recommendations are also contained in the plan.

The City of Farragut does not have as much ridgetop area as the City of Knoxville and Knox County. However, slope and soil slippage potential should be considered in plans for future development.

Severe Storms Vulnerability

Overview

Planning Significance: High

Windstorm is primarily a public safety and economic concern, and the planning area is located in a region with high frequency of occurrence. Windstorm can cause damage to structures and power lines which in turn can create hazardous conditions for people. Debris flying from high wind events can shatter windows in structures and vehicles and can harm people that are not adequately sheltered.

Potential Losses to Existing Development

Manufactured Homes

Campers, manufactured homes, barns, and sheds and their occupants are particularly vulnerable as windstorm events in the planning area can be sufficient in magnitude to overturn these lighter structures. Table 3.47 provides the estimated numbers of manufactured homes in each jurisdiction in the planning area.

Table 3.47 Manufactured Homes in Planning Area

Jurisdiction	# of Manufactured Homes
Knox County (unincorporated)	8,150
Knoxville	1,087
Farragut	62
Total	**9,299**

Source: http://www.city-data.com/county/Knox_County-TN.html

Loss of Use

Overhead power lines and infrastructure are also vulnerable to damages from windstorms and extreme heat can cause brownouts or blackouts due to increased strain on the power grid. Potential losses would include cost of repair or replacement of damaged facilities, lost economic opportunities for businesses. Secondary effects from loss of power could include damage to equipment due to power surges in the electrical grid during brownouts or blackouts. Public safety hazards include risk of electrocution from downed power lines. Specific amounts of estimated losses are not available due to the complexity and multiple variables associated with this hazard.

Property Losses

Estimated damages from thunderstorms (including hail, high winds, and lightning) in the NCDC database for the 18 year period were reported to be $2.566 Million in property damages. This translates to estimated annualized losses of $142,555.

Future Development

Future development projects should consider windstorm hazards at the planning, engineering and architectural design stage with the goal of reducing vulnerability.

Tornado Vulnerability

Overview

Planning Significance: Medium

The planning area is located in a region of the U.S. with low to moderate tornado risk.

Potential Losses to Existing Development

With the many variables associated with tornadoes, it is difficult to quantify potential losses to existing development. Tornado variables include, but are not limited to the following: tornado intensity, tornado ground path length and width, time of day,

development density of ground path, population density of ground path, and prevalent construction materials/methods in ground path. With these many unknown variables in mind, an attempt has been made to estimate losses based on several assumptions as well as statistics gathered from a historical event, the May 15, 2003 F1 south Knoxville tornados that touched down at two separate locations were 50 yards wide and a total of 2.3 miles long. Thus assuming a .0653 square mile area was affected by the tornadoes paths.

Using that assumption above, the number of houses in a .0653 square mile area was figured for each jurisdiction based on the housing density. It should be noted that generally, the length of a tornado is greater than its width. However, to apply this methodology to multiple jurisdictions with varying dimensions, the path was converted to square miles. The number of homes was determined for .0653 square miles and then multiplied by the average home value for each jurisdiction to arrive at an estimated value of homes in .0653 square miles for each jurisdiction. This represents the value of homes exposed in an estimated tornado path. The level of damages would then depend on the magnitude of a specific tornado.

Table 3.48 provides the results of the vulnerability analysis. This vulnerability analysis methodology reveals that Farragut has the highest value of homes in a .0653 potential tornado path.

Table 3.48 Tornado Vulnerability Analysis

Jurisdiction	Land Area (sq. miles)	Housing Density	Houses in .0653 square miles	Average Home Value	Value of Homes in .0653 sq. mi. (Exposure)
Knox County (unincorporated)	526	337	22	$147,200	$3,238,400
City of Knoxville	104	917	60	$109,600	$6,576,000
Town of Farragut	16.09	412	27	$293,900	$7,935,300
Total					**$17,749,700**

Source: Housing Density, Census 2000; Average Home Value 2005-2009 American Community Survey 5-Year Estimates

Future Development

Future development that occurs in the planning area should consider tornado and high wind hazards at the planning, engineering and architectural design stages. Public buildings such as schools, government offices, as well as other buildings with a high occupancy and manufactured home parks should consider inclusion of a tornado saferoom to shelter occupants in the event of a tornado.

Wildfire Vulnerability

Overview

Planning Significance: Medium

Areas that are most vulnerable to wildfire are agricultural areas where land is burned, rural areas where trash and debris are burned, and the wildland-urban interface areas.

Potential Losses to Existing Development

According to the Tennessee Department of Agriculture, Division of Forestry, Knox County has had 46 wildfires that burned 840 acres between 2006 and 2010. There was no structural damage to homes or outbuildings in the nearby fires. Table 3.49 shows the value of homes and outbuildings saved during these wildfire events that total over $23.8 million.

Table 3.49 Value of Homes and Out Buildings Saved from Wildfires, Knox County, 2006-2010

Year	# Fires	Acres Burned	Homes Saved/ $ Value	Out Bldgs Saved/ $ Value
2006	6	21	0	1/1 million
2007	16	513	22/2.4 million	7/12.5 million
2008	7	119	7/1.5 million	1/100.00
2009	11	177	18/2.8 million	2/1.4 million
2010	6	10	7/2.2 million	1/2000.00
Totals	**46**	**840**	**54/8.9 million**	**12/14,902,100**

Source: Tennessee Department of Agriculture, Division of Forestry, Incident Fire Reporting System

Future Development

Future development in the wildland-urban interface would increase vulnerability to this hazard. Especially since the number one ranking cause of these wildfires is human caused – debris burning.

Winter Storm Vulnerability

Vulnerability Overview

Planning Significance: Medium.

The entire planning area is vulnerable to the effects of winter storm. Winter storms tend to make driving more treacherous and can impact the response of emergency vehicles. The probability of utility and infrastructure failure increases during winter storms due to freezing rain accumulation on utility poles and power lines. Elderly populations are considered particularly vulnerable to the impacts of winter storms.

Potential Losses to Existing Development

Buildings with overhanging tree limbs are more vulnerable to damage during winter storms. Businesses experience loss of income as a result of closure during power outages. In general heavy winter storms increase wear and tear on roadways though the cost of such damages is difficult to determine. Businesses can experience loss of income as a result of closure during winter storms.

Knox County has been included in one Emergency Presidential Disaster Declaration for winter storm events (DR 3095) in 1993. Table 3.50 lists the FEMA Public Assistance funds received and the total disaster costs for the jurisdictions. The total disaster cost for the public in this planning area was $846,337.14. Similar events would involve similar costs.

Table 3.50 Emergency FEMA DR-3095 Public Assistance Funds Received

Jurisdiction	Public Assistance 87.5% Contracted Eligible Share	Local Share 12.5%	Total Disaster Cost
Knox County	$318,162.00	$45,451.71	$363,613.71
City of Knoxville	$415,133.50	$59,304.75	$474,438.29
Town of Farragut	$7,249.50	$1,035.64	$8,285.14
Total	**$740,545.00**	**$105,792.10**	**$846,337.14**

Source: Tennessee Emergency Management Agency, Public Assistance Program

Loss of Use

Overhead power lines and infrastructure are also vulnerable to damages from winters storm, in particular ice accumulation during winter storm events can cause damages to power lines due to the ice weight on the lines and equipment as well as damage caused to lines and equipment from falling trees and tree limbs weighted down by ice. Potential losses would include cost of repair or replacement of damaged facilities, lost economic opportunities for businesses. Secondary effects of loss of power could include burst water pipes in homes without electricity during winter storms. Public safety hazards include risk of electrocution from downed power lines. Specific amounts of estimated losses are not available due to the complexity and multiple variables associated with this hazard. The loss of use estimates provided in Table 3.51 below were calculated using FEMA‘s publication What is a Benefit?: Guidance on Benefit-Cost Analysis of Hazard Mitigation Project, June 2009. These figures are used to provide estimated costs associated with the loss of power in relation to the populations served in each jurisdiction. The loss of use is provided in the heading as the loss of use cost per person per day of loss. The estimated loss of use provided for each jurisdiction represents the loss of service of the indicated utility for one day for 10 percent of the population. These figures do not take into account physical damages to utility equipment and infrastructure.

Table 3.51 Loss of Use Estimates for Power Failure Associated with Severe Winter Storms

Jurisdiction	Population (2010)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
Knox County (unincorporated)	432,226	43,223	$5,446,098
City of Knoxville	178,874	17,887	$2,253,762
Town of Farragut	20,676	2,068	$260,568
Total			**$7,960,428**

Property Losses

According to reports from the NCDC, there were 27 occurrences of winter storms in the planning area and total reported property damages of $506,000 during the 18-year period from 1993 to 2010. This computes to an average annual property loss of $28,111.

Increase Risk Populations

Elderly populations are considered to be at increased risk to Winter Storms. Table 3.52 provides the number and percent of population over 65 in the planning area. The Town of Farragut has the highest percentage of people over 65.

Table 3.52 Number and Percent of Population Over Age 65 in Knox County

Jurisdiction	Population Over 65	% of Population Over 65
Knox County (unincorporated)	27,419	12.4
City of Knoxville	23,944	13.1
Town of Farragut	2,824	14
Total Knox County	54,187	12.8

Source: 2005-2009 American Community Survey 5-Year Estimates, U.S. Census Bureau, http://factfinder.census.gov

Future Development

Future development could potentially increase vulnerability to this hazard by increasing demand on the utilities and increasing the exposure of infrastructure networks.

3.3.4 Future Land Use and Development

Knox County is experiencing a significant population growth. Table 3.53 provides information on changes in population and housing units in the planning area. All jurisdictions within the planning area are experiencing increases in population. The Town of Farragut's population increased the most with a 14.3 percent increase and their housing units also increased the most by 17 percent from 2000 to 2010. With all this population growth, the communities should monitor new development to ensure that it does not take place in hazard-prone areas, specifically in the floodplains, dam inundation areas and the wildland-urban interface.

Table 3.53 Change in Population and Housing Units

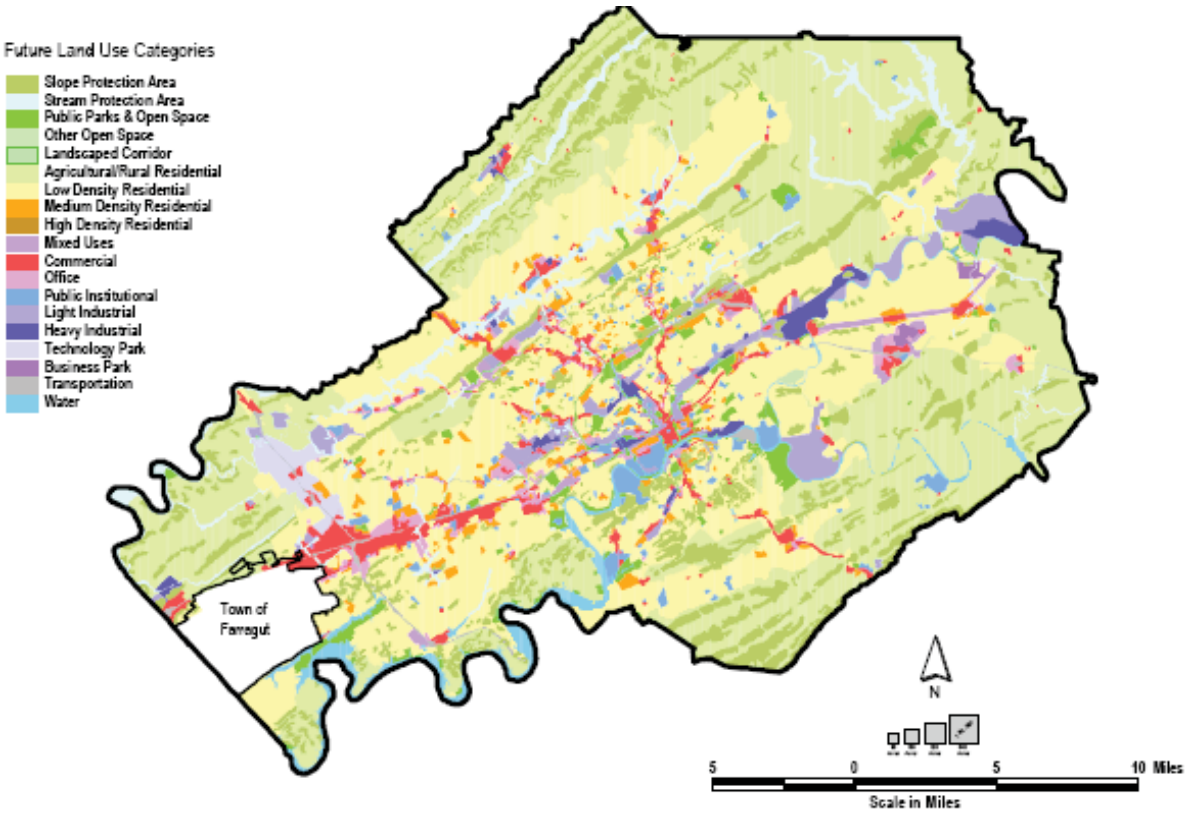
Location	2000 Population	2010 Population	Percent Change 2000-2010	2000 Housing Units	2010 Housing Units	Percent Change 2000 - 2010
Knox County (unincorporated)	382,032	432,226	11.6	171,439	194,949	12.0
City of Knoxville	173,890	178,874	2.8	84,981	88,009	3.4
Town of Farragut	17,718	20,676	14.3	6,627	7,982	17.0

Source: U.S. Census Bureau;

Planned Development/Expansion Activities

The Knoxville-Knox County Metropolitan Planning Commission completed a comprehensive plan, *General Plan 2033*, http://archive.knoxmpc.org/generalplan/Knox_GP2030.pdf . It outlines a vision statement, agenda for quality growth, action proposals, planning framework, plan elements, and development policies until the year 2033. The map in Figure 3.58 shows the planned future growth for the City and County.

Figure 3.58. **Future Land Use for Knoxville-Knox County**



Source: Knoxville-Knox County General Plan 2033

According to Farragut's Development Activity Report, dated 2010. development activity continues to be affected by the recession and the backlog of lots platted during the residential boom years. Permits for housing continued, but slow. In 2010, 46 building permits were issued for new principal buildings which were primarily for single-family houses.

Site plan activity maintained a slow but steady pace and as the economy improves it is anticipated that site plan approvals will quickly follow since the Town is well situated for such growth in various locations. The Turkey Creek Public market on the north side of the interstate may act as a catalyst for commercial/office activity in that portion of the Town along Outlet Drive.

3.3.5 Summary of Key Issues

Table 3.54 shows the results of the Hazard Ranking in order of High to Low Planning Significance based on the methodology described in section 3.1.

Table 3.54 Knox County Hazard Ranking-High to Low Planning Significance

Hazard	Probability	Magnitude	Spatial Extent	Planning Significance	Ranking
Severe Storms	4	2	3	3.1	High
Extreme Temperatures	4	2	3	3.1	High
Flood	4	2	3	3.1	High
Land subsidence & sinkholes	4	2	2	2.9	Medium
Winter Storms	4	1	3	2.75	Medium
Landslides	3	2	2	2.45	Medium
Wildfires	4	1	1	2.35	Medium
Earthquake	3	1	3	2.3	Medium
Tornado	3	2	1	2.25	Medium
Drought	2	2	1	1.8	Low
Dam Failure	1	2	2	1.55	Low
Expansive soils	1	1	1	1	Low

The following section summarizes key issues and questions for the planning committee brought out by the risk assessment.

Severe Storms

- Manufactured homes, campers and light buildings at increased risk of damages.
- Nearly 10,000 manufactured homes in the planning area, most in unincorporated areas.
- Causes power outages from downed power lines.
- Annualized losses estimated at $142,555 based on NCDC historical accounts.

Extreme Temperatures

- Persons over 65 and under 5 years old are especially vulnerable.
- Persons below poverty level may not be able to afford air conditioning/adequate heat.
- The Town of Farragut has the highest percentage of residents over age 65, at 14 percent. The unincorporated county has the highest percentage of residents under

5, at 6.3 percent, and the City of Knoxville has the highest percentage of population below the poverty level, at 25 percent.
- Power generation and transmission facilities can fail during periods of prolonged extreme heat.
- 16 long-term, nursing and Medicare rehabilitation facilities in Knox County.

Flood

- Repetitive Loss Properties in planning area. These are properties that have had 2 or more flood insurance payments of $5,000 or more in 10-year period. 19 in unincorporated county, 24 in City of Knoxville, and one in the Town of Farragut.
- Flashflooding occurs repeatedly in some known areas.
- Sinkhole Flooding occurs within the planning area.
- 100-year riverine flood could damage 786 buildings at cost of $442 million and displace nearly 9,000 residents.
- 875 flood insurance policies in force with $200 million in coverage.
- $10,656 annualized losses to crops due to flooding and excessive moisture.
- 82% of field crops are insured.
- 25 Critical Facilities in the Floodplain-(8 in unincorporated county (1 port facility), 15 in City of Knoxville (9 port facilities), and 2 in Farragut.

Land Subsidence & sinkholes

- 15 percent of City of Knoxville is built around or in sinkholes.
- Stormwater Management Manual contains polices/regulations for developments near sinkholes.

Winter Storm

- Damages to power lines and poles occur with winter storms.
- Causes closure of businesses and schools.
- 1993 FEMA declaration resulted in $846,337 in FEMA payments for emergency assistance.
- Based on population and FEMA loss of use estimates, loss of power to 10% of residents would equate to over $7.9 million in damages per day.
- NCDC annualized losses are $28,111.

Landslide

- All of planning area has at least moderate susceptibility/low incidence to landslide. Some portions with high susceptibility/moderate incidence.
- Two reported damaging landslides in 10-year period.
- Hillside and Ridgetop Protection Plan under consideration by City of Knoxville and Knox County.

Wildfire

- From 2006-2010, Knox County had 46 wildfires that burned 840 acres.
- Areas most vulnerable are agricultural areas where land is burned, rural areas where trash is burned, and wildland-urban interface areas.

Earthquake

- Knox County experiences frequent low-magnitude events (13 in a six-month period/ none exceeded 2.5 magnitude.
- 5.0 Magnitude earthquake has 10-12 percent probability in next 100 years.
- HAZUS loss estimates for 2,500 year Probabilistic Event in Knox County estimate nearly $3 billion in damages including structure, contents, and inventory and over 3,000 displaced households Loss estimates are highest in the City of Knoxville.
- Do building codes include seismic design requirements?

Tornado

- Almost 10,000 manufactured homes in the planning area, most are in unincorporated areas.
- Do mobile home parks have tornado saferooms for residents?
- A .0653 square mile tornado path could impact an estimated 22 homes in unincorporated county, 60 in City of Knoxville, and 27 in Town of Farragut.
- Do Knox County schools and other public buildings have tornado saferooms?
- Do residents have adequate shelter areas available to them?
- Are indoor and outdoor warning systems adequate?

Drought

- Drought reduces energy production from hydroelectric plants that service the planning area.
- Drought can impact water supply for water distribution facilities.
- Over 25% of land in planning area is used for agricultural purposes, mostly in the unincorporated county.
- Average annual paid claims for crop insurance as a result of drought were $3,224 from 2000-2009.

Dam Failure

- Dam Inundation Maps are needed from TVA to determine vulnerability.
- 1 State-regulated dam (Victor Ashe Dam)—no Emergency Action Plan on file. Although this is not required by the state, it would be useful to the City of Knoxville in the event of failure.
- Do jurisdictions have dam breach inundation zoning ordinances to restrict development in inundation areas?

Expansive Soils

- Damages to existing development are largely isolated incidents and affected property owners make necessary repairs.

4 MITIGATION STRATEGY

44 CFR Requirement 201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

This section presents the mitigation strategy developed by the Hazard Mitigation Planning Committee (HMPC) based on the risk assessment. The mitigation strategy was developed through a collaborative group process and consists of general goal statements and objectives to guide the jurisdictions in efforts to lessen disaster impacts as well as specific mitigation actions that can be put in place to directly reduce vulnerability to hazards and losses. The following definitions are based upon those found in FEMA publication 386-3, *Developing a Mitigation Plan* (2002):

- **Goals** are general guidelines that explain what you want to achieve. Goals are defined before considering how to accomplish them so that they are not dependent on the means of achievement. They are usually long-term, broad, policy-type statements.
- **Mitigation Actions** are specific actions that help achieve goals and objectives.

4.1 Goals

44 CFR Requirement 201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

The HMPC developed goals to provide direction for reducing hazard-related losses in Knox County. These were based upon the results of the risk assessment and a review of mitigation goals from other state and local plans, specifically, the Tennessee Hazard Mitigation Plan, 2010. This review was to ensure that this plan's mitigation strategy was integrated or aligned with existing plans and policies.

Through a brainstorming process at their second meeting, the HMPC came to a consensus on four main goals. The goals of the mitigation strategy are listed below, in no particular order:

1. Minimize, prevent or reduce the vulnerability of the people, property, environment, and economy of Knox County, City of Knoxville and Town of Farragut to the impacts of natural hazards.
2. Increase citizen awareness and preparedness by providing information describing all types of hazards, methods for preventing damage, and how to respond.
3. Protect critical facilities and infrastructure from natural hazards.

4. Create a disaster resistant community by involving elected officials, individuals in the private and public sector to participate in hazard mitigation planning and training activities geared towards reducing the impact of disasters in Knox County, City of Knoxville, and Town of Farragut.

4.2 Identification and Analysis of Mitigation Actions

44 CFR Requirement §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 effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

During the second meeting of the HMPC, the results of the risk assessment were provided to the HMPC members for review. After reviewing the results of the risk assessment, the committee discussed the key issues that were identified for specific hazards. In addition, AMEC provided the HMPC with information on the Tennessee Emergency Management Agency HMGP funding priorities and the types of mitigation actions generally recognized by FEMA. A handout was provided with the following types of mitigation actions, which originated from the National Flood Insurance Program's Community Rating System, as well as definitions and examples for each type of action:

- **Prevention:** Administrative or regulatory actions or processes that influence the way land and buildings are developed and built,
- **Property protection:** Actions that involve the modification of existing buildings or structures to protect them from a hazard or remove them from the hazard area,
- **Structural:** Actions that involve the construction of structures to reduce the impact of hazard,
- **Natural resource protection:** Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems,
- **Emergency services**: Actions that protect people and property during and immediately after a disaster or hazard event, and
- **Public education and awareness:** Actions to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigate them.

Committee members engaged in discussion regarding the types of mitigation actions or projects that could be implemented in the planning area. Consideration was given to the identified key issues and the anticipated success of each project type. This type of group discussion allowed the committee as a whole to understand the broad priorities and discussion of the types of projects most beneficial to all jurisdictions within Knox County. After meeting two, coordination with HMPC members continued to fully develop the mitigation strategy. Appendix C contains a comprehensive list of the types of actions discussed that resulted in the final mitigation strategy for this mitigation plan.

4.3 Implementation of Mitigation Actions

44 CFR Requirement §201.6(c)(3)(ii): The mitigation strategy shall include an action strategy describing how the actions identified in paragraph (c)(2)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefits review of the proposed projects and their associated costs.

Projects were discussed within the context of the STAPLEE criteria and the likelihood of success/failure for each action. STAPLEE is a tool used to assess the costs and benefits, and overall feasibility of mitigation actions. STAPLEE stands for the following:

- **Social**: Will the action be acceptable to the community? Could it have an unfair effect on a particular segment of the population?
- **Technical**: Is the action technically feasible? Are there secondary impacts? Does it offer a long-term solution?
- **Administrative**: Are there adequate staffing, funding, and maintenance capabilities to implement the project?
- **Political**: Will there be adequate political and public support for the project?
- **Legal**: Does your jurisdiction have the legal authority to implement the action?
- **Economic**: Is the action cost-beneficial? Is there funding available? Will the action contribute to the local economy?
- **Environmental**: Will there be negative environmental consequences from the action? Does it comply with environmental regulations? Is it consistent with community environmental goals?

  Mitigation Effectiveness:

  Then the following questions are asked pertaining to the mitigation effectiveness as it relates to life/safety and/or reduction or prevention of damages.

- Will the implemented action result in lives saved?
- Will the implemented action result in a reduction of disaster damages?

Figure 4.1 is the modified STAPLEE Form Worksheet given to the jurisdictions to complete for each mitigation action submitted to the plan.

Figure 4.1 Modified STAPLEE Worksheet for Feasibility of Proposed Mitigation Actions

KNOX COUNTY
MULTI-JURISDICTIONAL
LOCAL HAZARD MITIGATION PLAN

Action Title:	Jurisdiction:

STAPLEE Criteria	Evaluation Rating Definitely YES = 3 Maybe YES = 2 Probably NO = 1 Definitely NO = 0	Score
S: Is it Socially acceptable?		
T: Is it Technically feasible and potentially successful?		
A: Does the jurisdiction have the administrative capacity to execute this action?		
P: Is it Politically acceptable?		
L: Is there Legal authority to implement?		
E: Is it Economically beneficial?		
E: Will the project have either a neutral or positive impact on the natural environment? (score a 3 if positive impact, 2 if neutral impact)		
Will historic structures be saved or protected?		
Could it be implemented quickly?		
STAPLEE Score		

Mitigation Effectiveness Criteria	Evaluation Rating	Score
Will the implemented action result in lives saved?	Assign from 5-10 points based on the likelihood that lives would be saved.	
Will the implemented action result in a reduction of disaster damages?	Assign from 5-10 points based on the relative reduction of disaster damages.	
Mitigation Effectiveness Score		

Total Score (STAPLEE Score + Mitigation Effectiveness Score): _____

Completed by (name/title/phone #): _____

Throughout the discussion of the types of projects that the committee would include in the mitigation plan, emphasis was placed on the importance of a benefit-cost analysis in determining project priority. The Disaster Mitigation Act regulations state that benefit-cost review is the primary method by which mitigation projects should be prioritized. Recognizing the federal regulatory requirement to prioritize by benefit-cost, and the need for any publicly funded project to be cost-effective, the HMPC decided to pursue implementation according to when and where damage occurs, available funding, political will, jurisdictional priority, and priorities identified in the Tennessee Hazard Mitigation Plan. Due to many variables that must be examined during project development, the benefit/cost review at the planning stage, will primarily consist of a qualitative analysis. For each action, the jurisdictions included a narrative describing the types of benefits that could be realized with implementation of the action. Where possible, the cost was estimated as closely as possible with further refinement to occur as project development occurs. Cost-effectiveness will be considered in additional detail when seeking FEMA mitigation grant funding for eligible projects identified in this plan. At that time, additional information will be researched to provide for a quantitative benefit-cost analysis.

After the group brainstorming session, individual jurisdictions were instructed to coordinate meetings with his or her jurisdictional planning team (where available) to discuss mitigation actions and to complete the mitigation action worksheets and STAPLEE Worksheets for each action that they wanted to include in the plan. Committee members were instructed to return completed action worksheets to AMEC.

It was decided that each individual jurisdiction should separately prioritize the actions they chose to include in the plan. This decision was made to avoid “competition” among jurisdictions in prioritizing actions. Each jurisdiction used the STAPLEE worksheet and scoring system to assist in developing the priority level for each action. All actions submitted to the plan are indicated with a high, medium, or low priority level.

Table 4.1 summarize the mitigation actions that the participating jurisdictions selected to submit to the plan, including the priority level, the STAPLEE score, plan goals addressed, and the hazards addressed.. The mitigation action implementation worksheets follow the action table in the same order they are presented in the summary table.

Table 4.1. Mitigation Action Matrix

Action ID	Action	Priority	STAPLEE Score	Goals	Hazards Addressed
	Knox County and Multi-jurisdictional Actions				
County-1	Secure funding for a buyout of flood prone properties that experience repetitive flooding.	H	38	1,4	Flood
County-2	Continue Participation in the National Flood Insurance Program (NFIP)*	H	39	1, 2, 4	Flood
County-3	Secure funding for roadway improvement projects that would protect roadways from repetitive flooding.	M	33	1,3	Flood
County-4	Secure funding for construction of regional detention basins.	L	30	1,3	Flood
MultiJ-1	Protect or relocate flood prone critical facilities.	H	37	1,3	Flood
MultiJ-2	Provide Back-up power for critical facilities (water system pumps, hospitals, nursing homes, schools, etc.)	H	37	1,3,	Earthquake, flood, sinkholes, landslide, severe storms, wildfire, winter storms
MultiJ-3	All Hazard Public Education	H	35	2,4	All Hazards
MultiJ-4	Wildfire Public Education	M	34	2,4	Wildfire
	City of Knoxville				
Knoxville-1	First Creek Improvements – Walker Blvd.	H	39	1,3	Flood
Knoxville-2	Cross Park Drive drainage	H	40	1,3	Flood
Knoxville-3	Floodway Acquisitions	H	37	1,3	Flood
Knoxville-4	First Creek Improvements – North of Tecoma	H	33	1,3	Flood
Knoxville-5	Floodprone Structure Acquisition	M	29	1,3	Flood
Knoxville-6	First Creek Improvements – Grainger	M	29	1,3	Flood
Knoxville-7	Prosser Road Improvements	M	28	1,3	Flood
Knoxville-8	Stormwater System Maintenance.	M	36	1,3	Flood
Knoxville-9	Improve NFIP Community Rating System*	M	38	1,2,4	Flood
Knoxville-10	4th Creek – Northshore Bridge Improvements	M	28	1,3	Flood
Knoxville-11	Cherry Street Sinkhole Maintenance	M	30	1, 3	Flood
Knoxville-12	4th Creek Channel Stabilization	M	28	1, 3	Flood

Action ID	Action	Priority	STAPLEE Score	Goals	Hazards Addressed
Knoxville-13	Construct tornado safe rooms in public buildings including schools.	M	30	1	Severe Storms & Tornadoes
Knoxville-14	WPA Stormwater	L	26	1,3	Flood
Knoxville-15	Secure funding for uninterruptible power supply battery-backup systems for traffic signals.	L	24	1	Severe storms, Flood, winter storms
	Town of Farragut				
Farragut-1	Construct tornado safe rooms in public buildings including schools.	M	30	1	Severe Storms & Tornadoes

*Denotes Actions related to continued compliance with the NFIP

The tables that follow provide additional details for each mitigation action identified by the planning committee. This information serves as the action plan describing how the actions will be prioritized, implemented, and administered by the local jurisdiction. The section on benefits or losses avoided if the action is implemented is primarily a qualitative review at this time. A more detailed and quantitative benefit-cost analysis was discussed and will be performed prior to implementation of actions when additional detailed project cost information has been developed.

Jurisdiction: Knox County	**Local Priority** (high, medium, low): High	**Hazards Addressed:** Flood
Action Title: **County-1**	Secure funding for a buyout of flood prone properties that experience repetitive flooding.	
Issue/Background: Why is this action needed? What is the problem?	A buyout of these properties and the subsequent removal of the flooded structures would keep these properties from experiencing repetitive flooding.	
Ideas for Implementation: How can the problem be solved?	By removing the structures that are experiencing repetitive flooding and restricting any future building replacements on these properties Knox County can assist in having these properties removed from the list of properties that experience repetitive flooding.	
Responsible Office: Which department would implement/track?	Knox County Engineering and Public Works	
Partners: Who would help?	Tennessee Emergency Management Agency , US Army Corp of Engineers, City of Knoxville, Legacy Parks Foundations, Knox County Parks and Recreation and its partners, Beaver Creek Watershed Assoc.	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	FEMA Hazard Mitigation Assistance Grants with local matching funds	
Cost Estimate:	Approx. 6 houses @ an average of $200,000.00 per property for a total of $1,200,000.00- $1,500,000.00 would possibly be involved.	
Benefits: (Losses Avoided)	All flooding claims originating from these properties and there repetitive claims would be avoided.	
Timeline: (How many months/years to complete?)	The project could probably be completed in 6-12 months.	
Completed by: (name/title/phone #)	Eddy Roberts Staff Drainage Engineer 865-215-5234	

Jurisdiction: Knox County	**Local Priority** (high, medium, low): High	**Hazards Addressed:** Flood
Action Title: **County-2**	Continue Participation in the National Flood Insurance Program (NFIP)	
Issue/Background: Why is this action needed? What is the problem?	• Numerous areas within Knox County lie within the designated flood plain. • Knox County participates in the NFIP and will continue to do so. • Knox County will continue to regulate development in the flood plain according to the flood plain management ordinance.	
Ideas for Implementation: How can the problem be solved?	• Continue participation in the NFIP and enforce current flood plain management ordinance.	
Responsible Office: Which department would implement/track?	Knox County Engineering and Public Works	
Partners: Who would help?	Knoxville, Farragut, Corps of Engineers, Tennessee Emergency Management Agency & FEMA.	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Local Funds	
Cost Estimate:	Unknown	
Benefits: (Losses Avoided)	• Prevention of loss of life and property within the designated flood zones. • Flood Insurance available to residents and businesses.	
Timeline: (How many months/years to complete?)	Ongoing Project.	
Completed by: (name/title/phone #)		

Jurisdiction: Knox County	**Local Priority** (high, medium, low): Medium	**Hazards Addressed:** Flood
Action Title: **County-3**	Secure funding for roadway improvement projects that would protect roadways from repetitive flooding.	
Issue/Background: Why is this action needed? What is the problem?	Construction of roadway improvement projects such as Central Avenue Pike, Asbury Road, Emory Road in the Powell area and others would keep regular flooding away from the roadways and allow safe passage through these areas by motorists.	
Ideas for Implementation: How can the problem be solved?	The construction of these roadway improvement projects would allow these roadways to be raised or realigned to alleviate flooding that is common to these roadways.	
Responsible Office: Which department would implement/track?	Knox County Engineering and Public Works	
Partners: Who would help?	US Army Corp of Engineers, US Environmental Protection Agency, Tennessee Department of Transportation, City of Knoxville and others.	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	FEMA Hazard Mitigation Assistance Grants with local matching funds	
Cost Estimate:	Approx. $150,000.00 for Asbury Rd., $500,000.00 for Central Ave. Pk., $2,000,000.00 for Emory Rd.	
Benefits: (Losses Avoided)	The possible elimination of the flooding possibilities for these roadways and any claims arriving from motorists or property owners resulting in the flooding of these areas.	
Timeline: (How many months/years to complete?)	The projects could probably be completed in 12- 24 months.	
Completed by: (name/title/phone #)	Eddy Roberts Staff Drainage Engineer 865-215-5234	

Jurisdiction: Knox County	**Local Priority** (high, medium, low): Low	**Hazards Addressed:** Flood
Action Title: **County-4**	Secure funding for construction of regional detention basins.	
Issue/Background: Why is this action needed? What is the problem?	Construction of regional detention basins would allow storm water storage that would alleviate flooding in some areas.	
Ideas for Implementation: How can the problem be solved?	The construction of regional detention basins would allow additional storage capacity of storm water in Knox County to alleviate the flooding of some properties that have experienced repetitive flooding.	
Responsible Office: Which department would implement/track?	Knox County Engineering and Public Works	
Partners: Who would help?	US Army Corp of Engineers, City of Knoxville, Legacy Parks Foundations, Knox County Parks and Recreation and its partners, Beaver Creek Watershed Assoc.	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	FEMA Hazard Mitigation Assistance Grants with local matching funds	
Cost Estimate:	Approx. $1,000,000.00 for purchase of properties and design and construction of these facilities.	
Benefits: (Losses Avoided)	The possible elimination of the flooding possibilities for several properties currently experiencing repetitive flood claims.	
Timeline: (How many months/years to complete?)	The project could probably be completed in 6-18 months.	
Completed by: (name/title/phone #)	Eddy Roberts Staff Drainage Engineer 865-215-5234	

Jurisdiction: MultiJ-1	**Local Priority** (high, medium, low): High	**Hazards Addressed:** Flood
Action Title:	Protect or relocate flood prone critical facilities.	
Issue/Background: Why is this action needed? What is the problem?	• Critical facilities are identified as such due to the critical need of others for their continued operation. • Unprotected critical facilities in the flood prone areas could become non-operational for long periods of time due to flooding.	
Ideas for Implementation: How can the problem be solved?	• Develop and implement methods for protecting flood prone critical facilities on a case-by-case basis. -or— • Relocate the critical facility,	
Responsible Office: Which department would implement/track?	Emergency Management	
Partners: Who would help?	Each critical facility, the jurisdiction in which they are located and others as required.	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	• Local funds—from each critical facility • Potential for some grant funding for local government facilities.	
Cost Estimate:	Unknown.	
Benefits: (Losses Avoided)	• Prevention from loss of critical facility. • Continuity of Operations for critical facility.	
Timeline: (How many months/years to complete?)	Ongoing	
Completed by: (name/title/phone #)		

Jurisdiction:	**Local Priority** (high, medium, low):	**Hazards Addressed:**
Action Title: **MultiJ-2**	Provide Back-up power for critical facilities (i.e. water system pumps, hospitals, nursing homes, schools, etc.)	
Issue/Background: Why is this action needed? What is the problem?	• Facilities are designated as "Critical Facilities" due to their required operation in relation to the health, safety, welfare and/or needs of the local communities they serve. • Disruption of critical facility operations could easily affect the health, safety or welfare of citizens—even to the point of life endangerment.	
Ideas for Implementation: How can the problem be solved?	• Plan for and Install back-up generators or UPS systems in each facility. • Or, as a minimum, determine and plan for alternate power sources—ie; pre-wire building for use of on-call, rented/loaned generators.	
Responsible Office: Which department would implement/track?	Emergency Management	
Partners: Who would help?	Knoxville Utilities Board, Hospitals, colleges & school districts; nursing homes and others as they are identified.	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Assistance Grants, Local Funds	
Cost Estimate:	Unknown	
Benefits: (Losses Avoided)	• Reduce the potential for loss of life & property • Reduce dangers to the health, safety and welfare of citizens • Provide for the continual needs of citizens	
Timeline: (How many months/years to complete?)	On-going.	
Completed by: (name/title/phone #)		

Jurisdiction: MultiJ-3	**Local Priority** (high, medium, low): High	**Hazards Addressed:** All
Action Title:	All Hazards Public Education	
Issue/Background: Why is this action needed? What is the problem?	• Citizens need to know how to protect themselves from, prepare for, respond to and recover from natural hazards. • Proper knowledge, individual preparation and care can prevent injury, illness and potential deaths.	
Ideas for Implementation: How can the problem be solved?	• Provide public education talks, seminars, meetings with various groups, planning sessions, training, exercises, etc. • Provide information thru websites; cell phones; newspapers, theatres, billboards, fliers, PSAs, television ads and other multimedia sources, • Provide educational materials to schools, hospitals, senior citizen centers, long-term care facilities, business & industry and individuals.	
Responsible Office: Which department would implement/track?	Emergency Management & Public Health Departments	
Partners: Who would help?	CERT; RACES; Neighbourhood Groups; American Red Cross; Salvation Army and many others throughout the County.	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Grants, local funding or a combination of both.	
Cost Estimate:	Depends on the magnitude of the public education program being conducted.	
Benefits: (Losses Avoided)	• Prevention of sickness, injuries or potential death. • Public Awareness of actions to take to prepare for and respond to the emergency.	
Timeline: (How many months/years to complete?)	On-going.	
Completed by: (name/title/phone #)		

Jurisdiction: MultiJ-4	**Local Priority** (high, medium, low): High	**Hazards Addressed:** Wildfire
Action Title:	Wildfire public education	
Issue/Background: Why is this action needed? What is the problem?	Before peak conditions and occurrences of wildfire danger occur, homeowners living in the wildland/urban interface need to have the knowledge to prepare their homes and property to be as safe and defendable as possible.	
Ideas for Implementation: How can the problem be solved?	Educational workshops could be delivered for homeowners, associations and/or in rural communities to provide homeowners with property in the wildland/urban interface information on steps that they can take on their own to defend their property from wildfire. Existing programs such as the FIREWISE Communities USA program could be used to supplement local knowledge and expertise provided by the local fire departments and the Tennessee Forest Service in providing the needed information at these workshops	
Responsible Office: Which department would implement/track?	Tennessee Forest Service and local fire districts	
Partners: Who would help?	Homeowners associations, rural communities	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	• Tennessee Forest Service	
Cost Estimate:	Local funds	
Benefits: (Losses Avoided)	Protect loss of life and property.	
Timeline: (How many months/years to complete?)	Ongoing	
Completed by: (name/title/phone #)		

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): High	**Hazards Addressed:** Floods
Action Title: Knoxville-1	First Creek Improvements - Walker Blvd	
Issue/Background: Why is this action needed? What is the problem?	The roads and neighborhood adjacent to this section of First Creek chronically flood. The flood waters block arterial streets and possibly prevent access to the hospital or other essential services. Numerous cases of structure flooding have occurred, especially along Fairmont Blvd and Tecoma Drive. Floods occur in storm greater than the 5 year storm. Channel improvements downstream of this area are scheduled to be complete 2011.	
Ideas for Implementation: How can the problem be solved?	Acquire property to restore the floodplain and install approximately 3,100 feet of high flow bench from N. Broadway north to the Tecoma Tributary.	
Responsible Office: Which department would implement/track?	City of Knoxville Department of Engineering	
Partners: Who would help?	City of Knoxville Department of Engineering	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Grant Program, Local Funds	
Cost Estimate:	$5,500,000	
Benefits: (Losses Avoided)	Human life, business and residential flood claims	
Timeline: (How many months/years to complete?)	5 years	
Completed by: (name/title/phone #)	Jon Livengood Stormwater Engineer 865-215-3145	

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): High	**Hazards Addressed:** Floods
Action Title: Knoxville-2	Cross Park Drive drainage	
Issue/Background: Why is this action needed? What is the problem?	Cross Park Drive floods several times yearly. Structure flooding has sometimes occurred to adjacent buildings. Several cars have been flooded in parking lots. Many cars have been flooded while driving this section of road. Lack of access during periods of flooding causes traffic delays. Emergency vehicles may have limited access to a nearby nursing home during times of flood.	
Ideas for Implementation: How can the problem be solved?	Replace the existing undersized drainage system with a high capacity box culvert, approximate length of 2,000 feet. Project will require easements on private property.	
Responsible Office: Which department would implement/track?	City of Knoxville Department of Engineering	
Partners: Who would help?	City of Knoxville Department of Engineering	
Funding Source: (Grants-specific if known, local funds, combination, etc.)	Local Funds	
Cost Estimate:	$3,735,868	
Benefits: (Losses Avoided)	Human life, business and residential flood claims	
Timeline: (How many months/years to complete?)	The Notice to Proceed was issued on 7/28/14 and the contract completion date is 4/24/15.	
Completed by: (name/title/phone #)	Jon Livengood Stormwater Engineer 865-215-3145	

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): High	**Hazards Addressed:** Floods
Action Title: Knoxville-3	Floodway Acquisitions	
Issue/Background: Why is this action needed? What is the problem?	There are many structures that are within the floodway in the City of Knoxville. These obstructions chronically flood themselves, and increase upstream flooding.	
Ideas for Implementation: How can the problem be solved?	Acquire properties with structures in the floodway, demolish the structure and restore the floodplain.	
Responsible Office: Which department would implement/track?	City of Knoxville Department of Engineering	
Partners: Who would help?	City of Knoxville Department of Engineering	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Grant Program, Local Funds	
Cost Estimate:	$500,000 annually	
Benefits: (Losses Avoided)	Human life, business and residential flood claims	
Timeline: (How many months/years to complete?)	1 year	
Completed by: (name/title/phone #)	Jon Livengood Stormwater Engineer 865-215-3145	

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): High	**Hazards Addressed:** Floods
Action Title: Knoxville-4	First Creek Improvements – North of Tecoma	
Issue/Background: Why is this action needed? What is the problem?	The roads and neighbourhood adjacent to this section of First Creek chronically flood. The flood waters block arterial streets and possibly prevent access to the hospital or other essential services. Numerous cases of structure flooding have occurred, especially along Fairmont Blvd and Tecoma Drive. Floods occur in storms greater than the 5 year storm. Channel improvements downstream of this area are scheduled to be complete 2011.	
Ideas for Implementation: How can the problem be solved?	Acquire property to restore the floodplain and install approximately 2,700 feet of high flow bench from the Tecoma Tributary north to I640. Bridge replacement at Mineral Springs Avenue and install two additional 10ft x 10 ft box culverts under N Broadway. This project, combined with the First Creek – Walker Boulevard project will lower the 25 year and 100 year flood water elevation by 1.9 feet and 1.4 feet	
Responsible Office: Which department would implement/track?	City of Knoxville Department of Engineering	
Partners: Who would help?	City of Knoxville Department of Engineering	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Grant Program, Local Funds	
Cost Estimate:	$8,000,000	
Benefits: (Losses Avoided)	Human life, business and residential flood claims	
Timeline: (How many months/years to complete?)	5 years	
Completed by: (name/title/phone #)	Jon Livengood Stormwater Engineer 865-215-3145	

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): Medium	**Hazards Addressed:** Floods
Action Title: Knoxville-5	Floodprone Structure Acquisition	
Issue/Background: Why is this action needed? What is the problem?	There are many chronic flooding properties within the City that cannot be protected by improvements to the stormwater system. Flood proofing the structures is unfeasible due to the low property value.	
Ideas for Implementation: How can the problem be solved?	Purchase properties, demolish structure and restore the floodplain. Properties will be prioritised based on the benefit/cost ratio of flood insurance claims to property value and flood plain improvement potential.	
Responsible Office: Which department would implement/track?	City of Knoxville Department of Engineering	
Partners: Who would help?	City of Knoxville Department of Engineering	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Grant Program, Repetitive loss grants, Local Funds	
Cost Estimate:	Up to $500,000 per year	
Benefits: (Losses Avoided)	Human life, limit residential flood claims	
Timeline: (How many months/years to complete?)	1 years	
Completed by: (name/title/phone #)	Jon Livengood Stormwater Engineer 865-215-3145	

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): Medium	**Hazards Addressed:** Floods
Action Title: Knoxville-6	First Creek Improvements - Grainger	
Issue/Background: Why is this action needed? What is the problem?	Chronic roadway and structure flooding of businesses and residences occur adjacent to this section of First creek. Sharp bend in the stream channel, coupled with bridge restrictions and restriction in the floodplain cause water to overflow the streams banks	
Ideas for Implementation: How can the problem be solved?	Install a high flow bench through a City park (approximately 400' long), between Glenwood and Grainger Avenue. Make bridge improvements at Glenwood and Grainger Avenue to allow a higher capacity. Restore floodplain with bioengineering techniques across N Broadway from Cecil Avenue. Property acquisition will be required for some of this work. These improvements should lower the 25 year and 100 year flood water surface elevations 2.9 feet and 2.1 feet.	
Responsible Office: Which department would implement/track?	City of Knoxville Department of Engineering	
Partners: Who would help?	City of Knoxville Department of Engineering	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Grant Program, Local Funds	
Cost Estimate:	$5,000,000	
Benefits: (Losses Avoided)	Human life, business and residential flood claims	
Timeline: (How many months/years to complete?)	5 years	

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): Medium	**Hazards Addressed:** Floods
Action Title: Knoxville-7	Prosser Road Improvements	
Issue/Background: Why is this action needed? What is the problem?	Prosser road floods multiple times a year. It floods to a depth that all four lanes will be inundated with over 5 feet of water. The road will often be blocked by flood waters for weeks at a time. The low elevation of this section of road does not allow the installation of a storm drain system.	
Ideas for Implementation: How can the problem be solved?	Perform a transportation study to determine in this road is needed. If it isn't needed, close the road. If it is needed, elevate the road to an elevation above the flood depths and/or install infiltration BMPs and improve adjacent sinkholes to drain the stormwater.	
Responsible Office: Which department would implement/track?	City of Knoxville Department of Engineering	
Partners: Who would help?	City of Knoxville Department of Engineering	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Local Funds	
Cost Estimate:	$1,442,974	
Benefits: (Losses Avoided)	Human life, limit residential flood claims	
Timeline: (How many months/years to complete?)	The Notice to Proceed was issued on 5/19/14 and the Contract Complete Date is 12/14/14.	
Completed by: (name/title/phone #)	Jon Livengood Stormwater Engineer 865-215-3145	

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): Medium	**Hazards Addressed:** Floods
Action Title: Knoxville-8	Stormwater System Maintenance.	
Issue/Background: Why is this action needed? What is the problem?	Numerous box culverts through out the City of Knoxville have accumulated sediment and debris reducing their capacity. During heavy rain events, the culverts cause stormwater to backup and flood adjacent property and compromise the structural stability of adjacent roads.	
Ideas for Implementation: How can the problem be solved?	Clear debris from all box culverts which streams flow through. This will be a multi-year program.	
Responsible Office: Which department would implement/track?	City of Knoxville Department of Engineering	
Partners: Who would help?	City of Knoxville Department of Engineering	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Grant Program, Local Funds	
Cost Estimate:	$50,000 per year.	
Benefits: (Losses Avoided)	Limit residential flood claims	
Timeline: (How many months/years to complete?)	5 years	
Completed by: (name/title/phone #)	Jon Livengood Stormwater Engineer 865-215-3145	

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): Medium	**Hazards Addressed:** Floods
Action Title: Knoxville-9	Improve NFIP Community Rating System	
Issue/Background: Why is this action needed? What is the problem?	Currently the City of Knoxville has a CRS rating of 8. By improving the CRS score, the City residents can get an improved discount on their flood insurance.	
Ideas for Implementation: How can the problem be solved?	Improve the public outreach program sending flood information to all properties in the community, sending a notice directed to properties in floodprone areas, and other projects such as “Flood Awareness Week” and Flood Insurance mailings.	
Responsible Office: Which department would implement/track?	City of Knoxville Department of Engineering	
Partners: Who would help?	City of Knoxville Department of Engineering	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Grant Program, Local Funds	
Cost Estimate:	$250,000 per year.	
Benefits: (Losses Avoided)	Improve flood awareness which may result in protection of property and life.	
Timeline: (How many months/years to complete?)	Annually	
Completed by: (name/title/phone #)	Jon Livengood Stormwater Engineer 865-215-3145	

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): Medium	**Hazards Addressed:** Floods
Action Title: Knoxville-10	4th Creek – Northshore Bridge Improvements	
Issue/Background: Why is this action needed? What is the problem?	4th Creek, along Northshore Drive, chronically overtops its banks and floods multiple roads and businesses. The flood waters prevent passage of emergency vehicles and results in excessive flood insurance claims.	
Ideas for Implementation: How can the problem be solved?	Replace multiple bridges over 4th Creek that restrict the flow of floodwaters.	
Responsible Office: Which department would implement/track?	City of Knoxville Department of Engineering	
Partners: Who would help?	City of Knoxville Department of Engineering	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Grant Program, Local Funds	
Cost Estimate:	$500,000 annually.	
Benefits: (Losses Avoided)	Reduces flood insurance claims and loss of life	
Timeline: (How many months/years to complete?)	5 years	
Completed by: (name/title/phone #)	Jon Livengood Stormwater Engineer 865-215-3145	

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): Medium	**Hazards Addressed:** Floods, Sinkholes
Action Title: Knoxville-11	Cherry Street Sinkhole Maintenance	
Issue/Background: Why is this action needed? What is the problem?	A sinkhole, located on Interstate right-of-way, was previously improved to drain the stormwater system of the adjacent interstate, N Cherry Street and Mitchell Street. Over time, the sinkhole has been clogged with approximately 20 feet of accumulated sediment over its throat. This causes the stormwater system to back up and flood Mitchell Street, making it impassable, as well as causes N Cherry Street's catch basins to overflow.	
Ideas for Implementation: How can the problem be solved?	Remove all accumulated sediment in the sinkhole to allow the stormdrain system to function properly.	
Responsible Office: Which department would implement/track?	City of Knoxville Department of Engineering	
Partners: Who would help?	City of Knoxville Department of Engineering, TDOT	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Grant Program, Local Funds	
Cost Estimate:	$200,000	
Benefits: (Losses Avoided)	Reduces road flooding and roadway safety concerns	
Timeline: (How many months/years to complete?)	1 year	
Completed by: (name/title/phone #)	Jon Livengood Stormwater Engineer 865-215-3145	

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): Medium	**Hazards Addressed:** Floods
Action Title: Knoxville-12	4th Creek Channel Stabilization	
Issue/Background: Why is this action needed? What is the problem?	On a tributary to 4th Creek, near Wellington Drive, the stream channel is severely eroding for approximately 600 feet of length. The stream banks are unstable and vertical to height in excess of 20 feet. This erosion is detrimental to the environmental health of the stream.	
Ideas for Implementation: How can the problem be solved?	Restore and stabilize stream banks with bioengineering techniques where possible, hard armour as needed.	
Responsible Office: Which department would implement/track?	City of Knoxville Department of Engineering	
Partners: Who would help?	City of Knoxville Department of Engineering	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Grant Program, Local Funds, Private Funds	
Cost Estimate:	$1,500,000	
Benefits: (Losses Avoided)	Improves and protects 4th Creek from environmental issues caused by excessive erosion, limits accumulation of sediment in downstream drainage structures.	
Timeline: (How many months/years to complete?)	5 year	
Completed by: (name/title/phone #)	Jon Livengood Stormwater Engineer 865-215-3145	

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): Medium	**Hazards Addressed:** Severe Storms & Tornadoes
Action Title: Knoxville-13	Construct tornado safe rooms in public buildings including school.	
Issue/Background: Why is this action needed? What is the problem?	• To protect the citizens, visitors, school children, faculty & staff	
Ideas for Implementation: How can the problem be solved?	Promote construction of tornado safe rooms when new public building or additions are being implemented. Construct the safe room in accordance with FEMA design standards 361.	
Responsible Office: Which department would implement/track?		
Partners: Who would help?	Emergency Management, Building Inspection, Public Works and Facilities Management	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Assistance Grants; local funding; etc.	
Cost Estimate:	In general, safe rooms cost $120 per square foot and 5 square foot is needed per person.	
Benefits: (Losses Avoided)	Potential loss of many lives.	
Timeline: (How many months/years to complete?)	Unknown.	
Completed by: (name/title/phone #)		

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): Low	**Hazards Addressed:** Floods
Action Title: Knoxville-14	WPA Stormwater	
Issue/Background: Why is this action needed? What is the problem?	Throughout the City, there are multiple WPA constructed channels and culverts. Due to their age many of the structures are in need of repair or replacement. If these structures fail, they may cause structure flooding and or roadway flooding/failure.	
Ideas for Implementation: How can the problem be solved?	Repair or replace as necessary the dilapidated WPA structures.	
Responsible Office: Which department would implement/track?	City of Knoxville Department of Engineering	
Partners: Who would help?	City of Knoxville Department of Engineering	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Grant Program, Local Funds	
Cost Estimate:	$200,000	
Benefits: (Losses Avoided)	Reduces potential for structure flooding and roadway flooding/failure.	
Timeline: (How many months/years to complete?)	1 year	
Completed by: (name/title/phone #)	Jon Livengood Stormwater Engineer (865) 215-3145	

Jurisdiction: City of Knoxville	**Local Priority** (high, medium, low): Low	**Hazards Addressed:** Severe Storms, Flood, Winter Storms
Action Title: Knoxville-15	Secure funding for uninterruptible power supply (UPS) battery-backup systems for traffic signals on critical roadway segments.	
Issue/Background: Why is this action needed? What is the problem?	Traffic signals operate only when electric power is available. When said power is not available, the signals are dark. Drivers approaching dark signals are required by law to treat the dark signals as all-way STOP conditions leading to substantial delay and safety concerns, especially during peak traffic periods. Therefore, it is desirable to implement a power backup system for as many traffic signal installations as feasible and cost-effective to maintain signal control during power outages.	
Ideas for Implementation: How can the problem be solved?	Most or all of Knox county's traffic signals are now equipped with light-emitting diode (LED) indications in place of the old incandescent bulbs. LED signals operate with relatively low current requirements so that it is possible to operate them using battery-supplied DC current for a brief period (generally tow to four hours) when AC grip power is not available. Several UPS battery systems are available to provide such backup power. With the installation of such UPS systems, signals can continue to operate during brief power outages related to storms or other events so that traffic can move more efficiently than with dark signals reducing delay and improving public safety.	
Responsible Office: Which department would implement/track?	Knox County Engineering and Public Works	
Partners: Who would help?	None.	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Assume combination of local and grant funds yet to be identified.	
Cost Estimate:	$557,600	
Benefits: (Losses Avoided)	Traffic delay to general public, increased potential of injury or fatal crashes arising from drivers ignoring dark signals, disruption of emergency service provider traffic arising from traffic congestion.	
Timeline: (How many months/years to complete?)	1 year	
Completed by: (name/title/phone #)	John Sexton, PE Staff transportation Engineer Knox County Engineering and Public Works (865) 215-5860	

Jurisdiction: Town of Farragut	**Local Priority** (high, medium, low): Medium	**Hazards Addressed:** Severe Storms & Tornadoes
Action Title: **Farragut-1**	Construct tornado safe rooms in public buildings including school.	
Issue/Background: Why is this action needed? What is the problem?	To protect the citizens, visitors, school children, faculty & staff	
Ideas for Implementation: How can the problem be solved?	Promote construction of tornado safe rooms when new public building or additions are being implemented. Construct the safe room in accordance with FEMA design standards 361.	
Responsible Office: Which department would implement/track?	Town of Farragut	
Partners: Who would help?	Emergency Management, Building Inspection, Public Works and Facilities Management	
Potential Funding Source: (Grants-specific if known, local funds, combination, etc.)	Hazard Mitigation Assistance Grants; local funding; etc.	
Cost Estimate:	In general, safe rooms cost $120 per square foot and 5 square foot is needed per person.	
Benefits: (Losses Avoided)	Potential loss of many lives.	
Timeline: (How many months/years to complete?)	Unknown.	
Completed by: (name/title/phone #)		

5 PLAN MAINTENANCE PROCESS

This chapter provides an overview of the overall strategy for plan maintenance and outlines the method and schedule for monitoring, updating, and evaluating the plan. The chapter also discusses incorporating the plan into existing planning mechanisms and how to address continued public involvement.

5.1 Monitoring, Evaluating, and Updating the Plan

44 CFR Requirement 201.6(c)(4): The plan maintenance process shall include a section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

5.1.1 Hazard Mitigation Planning Committee

With adoption of this plan, the HMPC will be tasked with plan monitoring, evaluation, and maintenance of the plan. The participating jurisdictions and agencies, led by the Knox County Stormwater Department, agree to

- Meet annually, and after a disaster event, to monitor and evaluate the implementation of the plan;
- Act as a forum for hazard mitigation issues;
- Disseminate hazard mitigation ideas and activities to all participants;
- Pursue the implementation of high priority, low- or no-cost recommended actions;
- Maintain vigilant monitoring of multi-objective, cost-share, and other funding opportunities to help the community implement the plan's recommended actions for which no current funding exists;
- Monitor and assist in implementation and update of this plan;
- Keep the concept of mitigation in the forefront of community decision making by identifying plan recommendations when other community goals, plans, and activities overlap, influence, or directly affect increased community vulnerability to disasters;
- Report on plan progress and recommended changes to the Knox County Commissioners and governing bodies of participating jurisdictions; and
- Inform and solicit input from the public.

The HMPC is an advisory body and will not have any powers over county, city, town, or district staff. Its primary duty is to see the plan successfully carried out and to report to the community governing boards and the public on the status of plan implementation and mitigation opportunities. Other duties include reviewing and promoting mitigation proposals, hearing stakeholder concerns about hazard mitigation, passing concerns on to appropriate entities, and posting relevant information on the County website.

5.1.2 Plan Maintenance Schedule

The HMPC agrees to meet annually and after a hazard event as appropriate to monitor progress and update the mitigation strategy. The Knox County Stormwater Department Head is responsible for initiating these plan reviews. In conjunction with the other participating jurisdictions, a five-year written update of the plan will be submitted to the Tennessee Emergency Management Agency and FEMA Region IV per Requirement §201.6(c)(4)(i) of the Disaster Mitigation Act of 2000, unless disaster or other circumstances (e.g., changing regulations) require a change to this schedule.

5.1.3 Plan Maintenance Process

Evaluation of progress can be achieved by monitoring changes in vulnerabilities identified in the plan. Changes in vulnerability can be identified by noting

- Decreased vulnerability as a result of implementing recommended actions,
- Increased vulnerability as a result of failed or ineffective mitigation actions, and/or
- Increased vulnerability as a result of new development (and/or annexation).

Updates to this plan will

- Consider changes in vulnerability due to action implementation,
- Document success stories where mitigation efforts have proven effective,
- Document areas where mitigation actions were not effective,
- Document any new hazards that may arise or were previously overlooked,
- Incorporate new data or studies on hazards and risks,
- Incorporate new capabilities or changes in capabilities,
- Incorporate growth and development-related changes to inventories, and
- Incorporate new action recommendations or changes in action prioritization.

In order to best evaluate any changes in vulnerability as a result of plan implementation, the participating jurisdictions will follow the following process:

- A representative from the responsible office identified in each mitigation action will be responsible for tracking and reporting on an annual basis to the jurisdictional lead on action status and providing input on whether the action as implemented meets the defined objectives and is likely to be successful in reducing vulnerabilities.
- If the action does not meet identified objectives, the jurisdictional lead will determine what additional measures may be implemented, and an assigned individual will be responsible for defining action scope, implementing the action, monitoring success of the action, and making any required modifications to the plan.

Changes will be made to the plan to accommodate for actions that have failed or are not considered feasible after a review of their consistency with established criteria, time frame, community priorities, and/or funding resources. Actions that were not ranked high but were identified as potential mitigation activities will be reviewed as well during

the monitoring and update of this plan to determine feasibility of future implementation. Updating of the plan will be by written changes and submissions, as the Knox County Emergency Management Agency deems appropriate and necessary, and as approved by the Knox County Commissioners and the governing boards of the other participating jurisdictions.

5.2 Incorporation into Existing Planning Mechanisms

44 CFR Requirement §201.6(c)(4)(ii): [The plan 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.

Where possible, plan participants will use existing plans and/or programs to implement hazard mitigation actions. Based on the capability assessments of the participating jurisdictions, communities in Knox County will continue to plan and implement programs to reduce losses to life and property from hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs and recommends implementing actions, where possible, through the following plans:

- General or master plans of participating jurisdictions
- Ordinances of participating jurisdictions
- Knox County Emergency Operations Plan
- Capital improvement plans and budgets
- Other community plans within the County, such as water conservation plans, stormwater management plans, and parks and recreation plans
- Other plans and policies outlined in the capability assessments in the jurisdictional annexes

HMPC members involved in updating these existing planning mechanisms will be responsible for integrating the findings and actions of the mitigation plan, as appropriate. The HMPC is also responsible for monitoring this integration and incorporating the appropriate information into the five-year update of the multi-hazard mitigation plan.

5.3 Continued Public Involvement

44 CFR Requirement §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.

The update process provides an opportunity to publicize success stories from the plan's implementation and seek additional public comment. Information will be posted in the Knoxville News Sentential and on the County website following the annual review of the mitigation plan. A public hearing(s) to receive public comment on plan maintenance and updating will be held during the update period. When the HMPC reconvenes for the update, it will coordinate with all stakeholders participating in the planning process, including those who joined the HMPC after the initial effort, to update and revise the

plan. Public notice will be posted and public participation will be invited, at a minimum, through available website postings and press releases to the local media outlets, primarily newspapers.

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APPENDIX B:
PLANNING PROCESS DOCUMENTATION

1. Kick-off Meeting Minutes
2. Meeting #2 Minutes
3. Meeting #3 Minutes
4. Hazard Mitigation Planning Meeting Attendance
5. Press Release-Public Comment During Plan Drafting Stage
6. County Website Screen Shot (Hazard Mitigation Plan Information)
7. Public Information/Survey Flyer
8. Press Release Announcing Final Public Comment Period
9. Neighboring jurisdictions and other key stakeholders invited to comment

1. Kick-off Meeting Minutes

To	**Knox County Stormwater Management**
From	**Chris Butler, Project Manager**
Tel / E-mail	**865-671-6774 / chris.butler@amec.com**

Subject **Minutes from Knox County Multi-jurisdictional Local Hazard Mitigation Planning Kickoff Meeting held on March 30, 2011, 6:00 – 8:00pm**

This document is a record of attendance and a summary of the issues discussed during the above meeting, including an introduction to the hazard mitigation planning process, the benefits to a multi-jurisdictional approach, classifying the probability and magnitude of hazards affecting Knox County, and next steps in this process.

Attendees

Name	Agency/Organization
Jon Livengood	City of Knoxville
Chad Weth	City of Knoxville
Lisa Hatfield	City of Knoxville
Bruce Giles	First Utility District
Craig Mayes	First Utility District
Billie Spicuzza	KCDC
Garrett McKinney	KGIS
Keith Stump	KGIS
Ellen Jenny	Knox County Air Quality
Roy Braden	Knox County Code Administration
Eddy Roberts	Knox County Engineering/Stormwater
Larry Hutsell	Knox County Health Department
Eric Hahn	Knox County Parks/Rec
Craig Leuthold	Knox County Property Assessor
Janet Drumheller	Knox County Public Library
Jerry Harnish	Knox County Rural/Metro Fire Department
Robert B. Sexton	Knox County Sheriff
Michael Hamrick	Knox County Stormwater
Chris Granju	Knox County Stormwater
Alan Lawson	Knox EMA
Roger Byrd	Knoxville Fire Department
Nate Allen	Knoxville Fire Department
Mark Donaldson	Knoxville-Knox County MPC
Kim Sepesi	Rural Metro
Daniel Johnson	Rural/Metro - Town of Farragut
Dennis Rowe	Rural/Metro EMS
Pete Lemiszki	TDEC-Geology
Darryl Smith	Town of Farragut
Chris Jenkins	Town of Farragut
Sue Stuhl	Town of Farragut
Ruth Hawk	Town of Farragut
Chris Butler	AMEC
Cindy Popplewell	AMEC
Catherine McMillen	AMEC

Introductions

Mr. Eddy Roberts, with Knox County Stormwater Management began the meeting by welcoming and thanking the attendees. The attendees introduced themselves and the jurisdiction they were representing, including the consulting firm, AMEC Earth and Environmental, hired to assist in the development of the Knox County multi-jurisdictional local hazard mitigation plan.

Introduction to Hazard Mitigation Planning

Mr. Butler, AMEC, presented information on the purpose and requirements of the Disaster Mitigation Act of 2000. The presentation addressed the benefits, including eligibility for federal funding programs, for jurisdictions participating in this mitigation plan.

Mr. Butler also described the role of the Hazard Mitigation Planning Committee. Jurisdictions participation in the committee requires:

- Designation of a representative to serve on the Knox County Hazard Mitigation Planning Committee, which will meet three times during the planning process,
- Assist in the development of a risk assessment and mitigation actions (at least one) specific to the jurisdiction,
- Provide Data as requested,
- Inform the public, local officials, and other interested parties about the planning process and provide opportunity for them to comment on the plan, and
- Formally adopt the mitigation plan.

Data Collection Workbook

AMEC provided electronic and hard copies of data collection workbook that included four worksheets on hazard identification, historic hazard events, vulnerability assessment on critical facilities, capability assessment of each jurisdiction, and mitigation strategy. Each worksheet was discussed and examples of data needed provided. Data was requested to be returned to Chris Butler, AMEC, by Friday, April 22nd.

Introduction to Hazard Identification

Mr. Butler presented information about the hazard profiles in the plan and introduced the committee to the elements of frequency of occurrence (probability of future occurrence), spatial extent, and potential magnitude to rank the hazards. The group reviewed the list of hazards already identified by Knox County that could affect the planning area. Mr. Butler presented research on each hazard and asked the committee to validate the probability and magnitude. Participants discussed past hazard events and the types of damage experienced. Listed below are the 12 hazards that the Knox County plan will focus on:

Dam Failure	Land subsidence & sinkholes
Drought	Landslides
Earthquake	Severe Storms
Expansive Soils	Tornado
Extreme Temperatures	Wildfires
Flood	Winter Storms

The following section summarizes committee discussion and comments:

Question/Comment	Response
Do we need to provide a map of the hazard?	Yes if possible - but not necessary
There is a TDEC Dam Safety Specialist in the Knoxville TDEC Field Office that can help with dam information	-
Concerns were brought up about the effect of dams upstream of Knoxville	-
Mudslide (referred to in slide) was not a natural event; was ultimately due to construction	-
Dutchtown Road is a highly populated area, floods often, affects a lot of people	-
Sinkholes also have flooding problems	-
There have been a few instances when Cedar Bluff Road was cut off for several days due to flooding	-
Police will typically enforce road closures during flooding events until the Highway Patrol can take over	-
There are several sinkholes on both sides of Campbell Station Road/ I-40/I-75	-
AMEC came up with the information for presentation from National Climactic Weather Database. FEMA requires public/government participation so that real/current/ representative hazards are included in the planning process.	-
There are approximately 600 fires per year in Knox County/Knoxville. However, most are not particularly destructive.	-
Statewide Mutual Aid System will allow Knox County to pull in resources (fire) as necessary. However, this has not been necessary. Typically, Knoxville/Knox County sends fire aid to surrounding counties.	-
AMEC - Any information provided on worksheet will be helpful. Please give as much information as possible.	-
Group consensus that holding workshops during working hours would be more convenient for everyone and may result in higher participation.	-
Town of Farragut has meeting facilities that could accommodate entire group. May be beneficial to rotate meeting/workshop locations.	-
How will the final plan be organized?	The Final Plan will be a Multi-Jurisdiction Plan that includes the City of Knoxville, Knox County, and the Town of Farragut.
Ridge top development was brought up as being a potential hazard.	-
AMEC - Make sure all participants keep track of the "In-Service" Time.	-

Next Steps

Attendees were asked to complete their jurisdiction's data collection workbook and to talk with other staff that may be knowledgeable about needed data. These data collection workbooks are due back to AMEC by Friday, April 22nd. **The next meeting of the Hazard Mitigation Planning Committee will be May 26, 2011.** A draft of the risk assessment will be provided at this meeting. The meeting will involve developing the plan's goals and objectives. As well as more discussions on each hazard's key elements from the risk assessment.

2. Meeting #2 Minutes

Memo

To **Knox County Stormwater Management**
From **Chris Butler, Project Manager**
Tel / E-mail **865-671-6774 / chris.butler@amec.com**

Subject **Minutes from Knox County Multi-jurisdictional Local Hazard Mitigation Planning Meeting held on May 26, 2011,**

This document is a record of attendance, and a summary of the issues discussed during the above meeting, including a review of the hazards identified in the plan, the draft risk assessment, development of plan goals, and the next steps in this process.

Attendees

Name	Agency/Organization
Jon Livengood	City of Knoxville
Chad Weth	City of Knoxville
Billie Spicuzza	KCDC
Ellen Jenny	Knox County Air Quality
John Sexton	Knox County Engineering
Eddy Roberts	Knox County Engineering/Stormwater
Craig Leuthold	Knox County Property Assessor
Janet Drumheller	Knox County Public Library
Jerry Harnish	Knox County Rural/Metro Fire Department
Jim Carico	Rural Metro
Pete Lemiszki	TDEC-Geology Division
Chris Jenkins	Town of Farragut
Sue Stuhl	Town of Farragut
Ruth Hawk	Town of Farragut
Elliott Sievers	Town of Farragut
Chris Butler	AMEC
Brooke Henry	AMEC
Mary Halley	AMEC

Introductions

Mr. Eddy Roberts, with Knox County Stormwater Management, began the meeting by welcoming and thanking the attendees. Chris Butler, AMEC's project manager for the plan, facilitated the remainder of the meeting and answered questions from the group.

Review of Hazard Mitigation Planning

Mr. Butler presented information on the purpose and requirements of the Disaster Mitigation Act of 2000. The presentation addressed the mitigation planning steps and how far the planning process is to date. Mr. Butler also reviewed the following participation requirements:

- Designate a representative to serve on the Knox County Hazard Mitigation Planning Committee, which will meet three times during the planning process,
- Assist in the development of a risk assessment and mitigation actions (at least one) specific to the jurisdiction,
- Provide data and comment on plan drafts as requested,
- Inform the public, local officials, and other interested parties about the planning process and provide opportunity for them to comment on the plan, and
- Formally adopt the mitigation plan.

Presentation of Results of Countywide Risk Assessment

The draft Risk Assessment, chapter 3 of the plan, was provided online at http://www.knoxcounty.org/stormwater/ . Mr. Butler asked that the HMPC individually provide comments & additional data back to AMEC by Thursday, June 23rd. Mr. Butler provided an overview of the key issues of the high and moderate hazards in the plan. Below are the Hazard Rankings in Knox County:

Hazard	Probability	Magnitude	Spatial Extent	Planning Significance	Ranking
Severe Storms	4	2	3	3.1	High
Extreme Temperatures	4	2	3	3.1	High
Flood	4	2	2	2.9	Medium
Land subsidence and sinkholes	4	2	2	2.9	Medium
Winter Storms	4	1	3	2.75	Medium
Landslides	3	2	2	2.45	Medium
Wildfires	4	1	1	2.35	Medium
Earthquake	3	1	3	2.3	Medium
Tornado	3	2	1	2.25	Medium
Drought	2	2	1	1.8	Low
Dam Failure	1	2	2	1.55	Low
Expansive soils	1	1	1	1	Low

Public Questionnaires

Public Questionnaires were distributed to the committee members and available online at http://www.knoxcounty.org/stormwater/. Per regulations, the public needs to be aware of this multi-jurisdictional local hazard mitigation plan in the drafting stage and comments gathered. The committee was asked to display these questionnaires in public places and to ask co-workers and neighbors to complete the short questionnaire on the backside. Questionnaires need to be returned to AMEC by June 10th.

Mitigation Goals

Mr. Butler provided samples of goals from other local mitigation plans. To provide structure to the exercise to develop goals for the mitigation plan, the committee discussed four main

categories of goals: Public Education, Planning/Training, Continuity of Operations, and protection of Critical Facilities. The sample goals were discussed and the committee completed a voting exercise to reach consensus on the goals for the Knox County mitigation plan. There were tie votes for several of the goals and then Knox County, City of Knoxville, and Town of Farragut made the final decisions after the meeting concerning the goals.

Here are the committee approved goals for the plan.

1. **Continuity of Operations:**
   Minimize, prevent or reduce the vulnerability of the people, property, environment, and economy of Knox County, City of Knoxville and Town of Farragut to the impacts of natural hazards.

2. **Public Education:**
   Increase citizen awareness and preparedness by providing information describing all types of hazards, methods for preventing damage, and how to respond.

3. **Critical Facility Protection:**
   Protect critical facilities and infrastructure from natural hazards.

4. **Planning/Training**
   Create a disaster resistant community by involving elected officials, individuals in the private and public sector to participate in hazard mitigation planning and training activities geared towards reducing the impact of disasters in Knox County, City of Knoxville, and Town of Farragut.

Mitigation Actions

The planning committee was provided an introduction to mitigation actions with the six categories of mitigation actions established by FEMA in their publication *Developing the Mitigation Plan.* At the next planning meeting, jurisdictions will develop their realistic mitigation action(s) for the plan that could be turned into projects.

The State of Tennessee has the following mitigation project priorities for mitigation grants:

1. Acquisition and Demolition of flood-prone properties
2. Flood Control (drainage improvement, retention/detention basin)
3. Tornado (reinforced corridors in schools and community shelters)
4. Earthquake (seismic retrofit)
5. Local Hazard Mitigation Plans

Next Steps

- Due Friday, June 10th public questionnaires due back to AMEC
- Due Thursday, June 23rd Comments on the Draft Risk Assessment
- Final Planning Meeting to develop Mitigation Actions on **Wednesday, June 29, 2011**.

3. Meeting #3 Minutes

Memo

To **Knox County Stormwater Management**
From **Chris Butler, Project Manager**
Tel / E-mail **865-671-6774 / chris.butler@amec.com**

Subject **Minutes from Knox County Multi-jurisdictional Local Hazard Mitigation Planning Meeting held on July 11, 2011,**

This document is a record of attendance, and a summary of the issues discussed during the above meeting, including a review of the hazards identified in the plan, the draft risk assessment, development of plan goals, and the next steps in this process.

Attendees

Name	Agency/Organization
Jon Livengood	City of Knoxville
Mark Donaldson	Metropolitan Planning Commission
Roger Byrd	City of Knoxville Fire Dept
John Sexton	Knox County Engineering
Eddy Roberts	Knox County Engineering/Stormwater
Eric Haun	Knox County P&R
Chris Butler	AMEC

Introductions

Mr. Eddy Roberts, with Knox County Stormwater Management, began the meeting by welcoming and thanking the attendees. Chris Butler, AMEC's project manager for the plan, facilitated the remainder of the meeting and answered questions from the group.

Review of Hazard Mitigation Planning

Mr. Butler presented information on the purpose and requirements of the Disaster Mitigation Act of 2000. The presentation addressed the status of the draft plan, review of the plan goals, discussion of mitigation actions and types of projects, and the plan maintenance schedule. Mr. Butler also reviewed the following participation requirements:

- Designate a representative to serve on the Knox County Hazard Mitigation Planning Committee, which will meet three times during the planning process,
- Assist in the development of a risk assessment and mitigation actions specific to the jurisdiction,
- Provide data and comment on plan drafts as requested,
- Inform the public, local officials, and other interested parties about the planning process and provide opportunity for them to comment on the plan, and
- Formally adopt the mitigation plan.

Presentation of Goals

Mr. Butler discussed the final goals of the hazard mitigation plan and provided detail on the connection to the mitigation actions. The following goals have been developed by the planning group and agreed upon by all jurisdictions:

- **Continuity of Operations:** Minimize, prevent or reduce the vulnerability of the people, property, environment, and economy of Knox County, City of Knoxville and Town of Farragut to the impacts of natural hazards.
- **Public Education:** Increase citizen awareness and preparedness by providing information describing all types of hazards, methods for preventing damage, and how to respond.
- **Critical Facility Protection:** Protect critical facilities and infrastructure from natural hazards.
- **Planning/Training:** Create a disaster resistant community by involving elected officials, individuals in the private and public sector to participate in hazard mitigation planning and training activities geared towards reducing the impact of disasters in Knox County, City of Knoxville, and Town of Farragut.

Public Questionnaires

Public Questionnaires were distributed to the committee members and available online at http://www.knoxcounty.org/stormwater/. Mr. Butler discussed the need for more community input and extend the review period for public questionnaires to June 30th.

Mitigation Actions

Mr. Butler discussed the principals behind the mitigation actions and presented the following guidance for developing mitigation actions.

- Losses from hazards can be reduced if states and communities take constructive action before the next disaster occurs
- Actions have long term and cumulative benefits
- Some may be low-cost initiatives readily adopted
- Others may be dependent on available funding or best implemented following a disaster
- Not all actions identified through this planning process will be eligible for FEMA grants

Mr. Butler also discussed the State priorities as presented in the State hazard Mitigation plan.

- Acquisition/Demolition
- Flood Control (Drainage Improvements, Retention/Detention Basin, warning system)
- Tornado (Reinforced Corridors in schools and community shelters, sirens)
- Earthquake (Seismic Retrofit)
- Local Hazard Mitigation Plans

Upon review the general guidance Mr. Butler discussed the specifics related to each type of mitigation actions as well as how the tie into the local HGMP plan. Upon reviewing the general guidance Mr. Butler led the group in an example exercise related to Tornado sirens. Mr. Butler worked through Mitigation Action Implementation worksheet and the STAPLEE worksheet. After the exercise Mr. Butler incorporated the working group to develop both worksheets.

Next Steps

- Due Friday, August 2nd Mitigation worksheets due back to AMEC
- Due Monday, Oct. 9th Comments on the Draft Hazard Mitigation Plan Risk
- Final Public Comment Meeting on **October, June 6, 2011**.

4. Hazard Mitigation Planning Meeting Attendance

Name	Representing	1st mtg	2nd mtg	3rd mtg
Jon Livengood	City of Knoxville	X	X	X
Chad Weth	City of Knoxville	X	X	
Lisa Hatfield	City of Knoxville	X		
Bruce Giles	First Utility District	X		
Craig Mayes	First Utility District	X		
Billie Spicuzza	KCDC	X	X	
Garrett McKinney	KGIS	X		
Keith Stump	KGIS	X		
Ellen Jenny	Knox County Air Quality	X	X	
Roy Braden	Knox County Code Administration	X		
John Sexton	Knox County Engineering		X	X
Eddy Roberts	Knox County Engineering/Stormwater	X	X	X
Larry Hutsell	Knox County Health Department	X		
Eric Hahn	Knox County Parks/Rec	X		X
Craig Leuthold	Knox County Property Assessor	X	X	
Janet Drumheller	Knox County Public Library	X	X	
Jerry Harnish	Knox County Rural/Metro Fire Department	X	X	
Robert B. Sexton	Knox County Sheriff	X		
Michael Hamrick	Knox County Stormwater	X		
Chris Granju	Knox County Stormwater	X		
Alan Lawson	Knox EMA	X		
Roger Byrd	Knoxville Fire Department	X		X
Nate Allen	Knoxville Fire Department	X		
Mark Donaldson	Knoxville-Knox County MPC	X		X
Kim Sepesi	Rural Metro	X		
Jim Carico	Rural Metro		X	
Daniel Johnson	Rural/Metro - Town of Farragut	X		
Dennis Rowe	Rural/Metro EMS	X		
Pete Lemiszki	TDEC-Geology Division	X	X	
Darryl Smith	Town of Farragut	X		
Chris Jenkins	Town of Farragut	X	X	
Sue Stuhl	Town of Farragut	X	X	
Ruth Hawk	Town of Farragut	X	X	
Elliott Sievers	Town of Farragut		X	

5. Press Release-Public Comment During Plan Drafting Stage

Knox County, Tennessee
PRESS RELEASE

Knox County Planning Committee Seeks Public Input

Knox County, TN — The Knox County Hazard Mitigation Planning Committee is seeking public input for the Knox County Multi-jurisdictional Local Hazard Mitigation Plan currently under development. A summary of the planning effort underway as well as a questionnaire to capture public opinion and comments will be available online and in hard-copy at public locations in Knox County from May 26 – June 10th, 2011. The purpose is to provide information to the public on the Hazard Mitigation Plan under development as well as gain public input.

Knox County has taken the lead to coordinate development of this plan and has drawn on the expertise of consultants with AMEC Earth and Environmental, Inc., a firm that specializes in hazard mitigation and emergency management. A planning committee comprised of representatives from Knox County, the City of Knoxville, and the Town of Farragut has been assembled to develop the comprehensive Multi-jurisdictional Local Hazard Mitigation Plan to reduce the vulnerability of people and property to the impacts of natural hazards and to become eligible for mitigation funding programs from the Federal Emergency Management Agency (FEMA). The plan will address a comprehensive list of hazards—ranging from flooding to landslides, tornados, and winter storms—and will assess the likely impacts of these hazards to communities in Knox County.

Due to presidential disaster declarations in Tennessee in recent years for tornado, severe storms, and flood disasters, funding is available to Tennessee communities through FEMA's Hazard Mitigation Grant Program for projects designed to reduce risk to lives and property from natural hazards. Only jurisdictions with a FEMA-approved hazard mitigation plan are eligible to submit project applications for these funds. The planning committee would like input from the public on the strategy being developed to lessen impacts of future disasters on people and property in the County.

Plan Information and a public questionnaire will be available as follows from May 26 – June 10th, 2011:

Online at: http://www.knoxcounty.org/stormwater/

In hard-copy at:

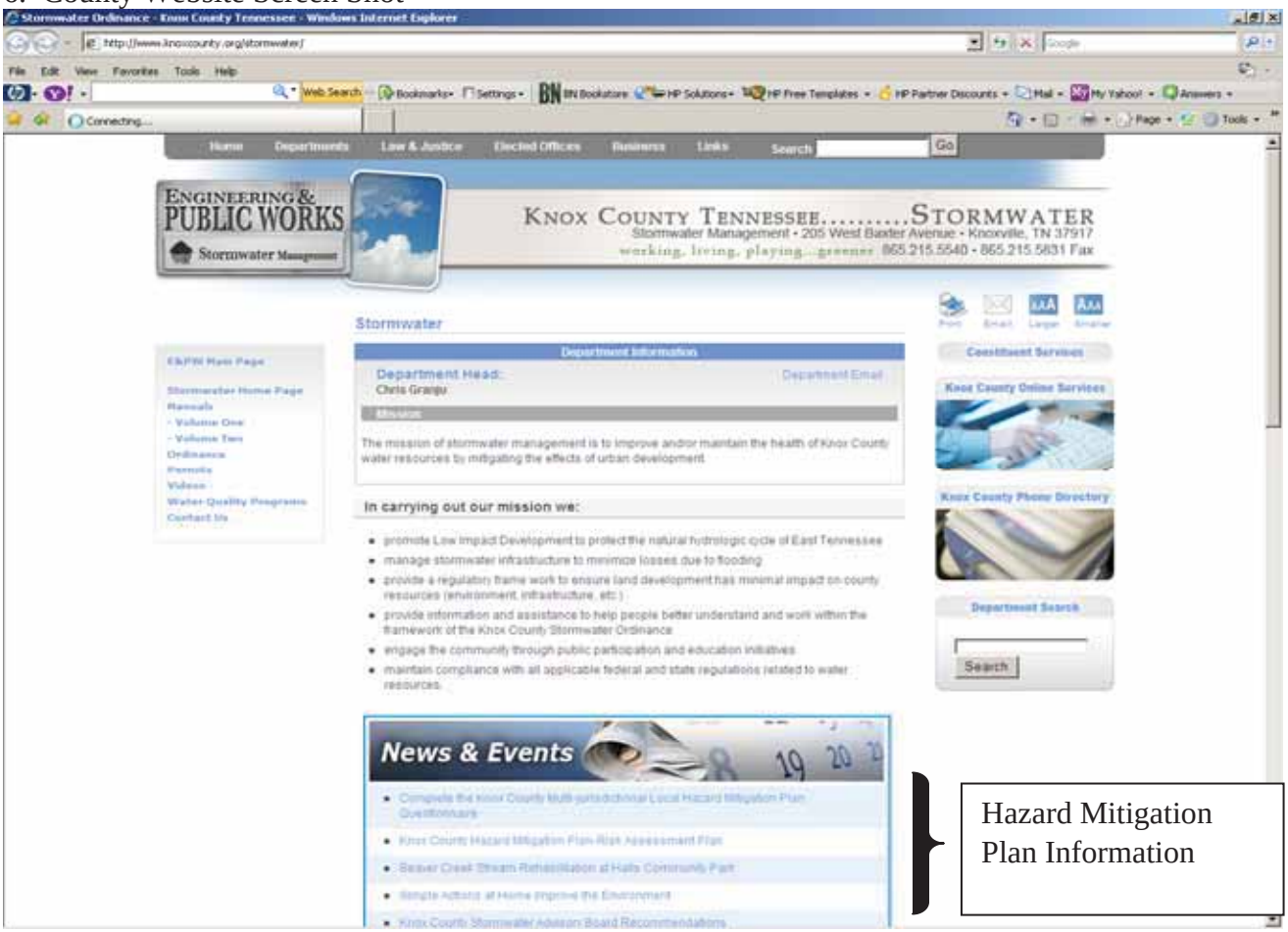
Knox County - Stormwater Department
205 West Baxter Avenue
Knoxville, TN 37917

City of Knoxville - Stormwater Management Department of Engineering
400 Main Street – Room 480
Knoxville, TN 37902

Farragut Town Hall
11408 Municipal Center Drive
Farragut, TN 37934

Feedback from the public will be used to inform the draft plan, which will be available for public review and comment later this year. Upon approval by the Tennessee Emergency Management Agency and FEMA, the plan will be presented to the Knox County Commissioners, the City of Knoxville, and the Town of Farragut for formal adoption. For more information on this project, contact: Eddy Roberts with the Knox County Stormwater Department at (865) 215-5234.

6. County Website Screen Shot



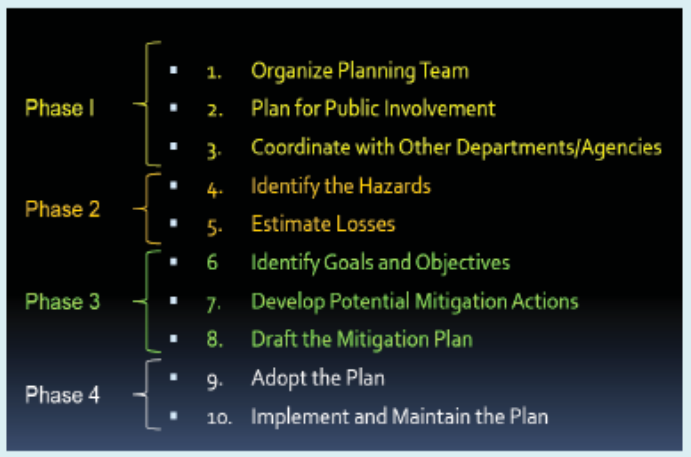
7. Public Information/Survey Flyer (side 1)

Knox County Multi-jurisdictional Local Hazard Mitigation Plan

Knox County is developing a comprehensive Multi-jurisdictional Local Hazard Mitigation Plan to better address potential natural hazards **before they occur** and to obtain eligibility for mitigation funding from the Federal Emergency Management Agency (FEMA). This is a **multi-jurisdictional planning process** and is a cooperative effort between Knox County, the City of Knoxville, and the Town of Farragut.

What Is a Hazard Mitigation Plan?

A hazard mitigation plan is the result of a planning process to determine how to reduce or eliminate the loss of life and property damage resulting from hazards. This plan will address a comprehensive list of natural hazards – ranging from flooding to landslides, tornados, and winter storms. The plan will assess the likely impacts of these hazards to communities in Knox County. This planning process is structured around four phases: Phase 1: Organize Resources, Phase 2: Assess Risks, Phase 3: Develop a Mitigation Plan, and Phase 4: Implement the Plan and Monitor Progress. These four phases are further broken down into 10 steps, shown in the box above.



Why is it Important to Me?

It is important for citizens to become involved in mitigation planning in their community. The planning team needs your input on the types of hazards that are your priority concern. Your opinion on ways to prevent or lessen the impacts of hazards is also valuable input for the planning team.

What Can I do to Participate?

Please complete and return the survey on the back to ensure your opinion is captured. Additionally, prior to being submitted to the Tennessee Emergency Management Agency and FEMA, the draft plan will be circulated for public comment. Information on accessing and commenting on the plan will be posted in local newspapers and the County's website in the future. Please visit http://www.knoxcounty.org/stormwater/ for additional information on ways you can participate.

For more information go to http://www.knoxcounty.org/stormwater/ or call (865) 215-5234

7. Public Information/Survey Flyer (side 2)

Please complete and return via mail, fax, or e-mail by 6/15 to:
Chris Butler, AMEC Earth & Environmental, Inc.
10239 Technology Drive
Knoxville, TN 37932
Fax: (865) 671-6254
e-mail: chris.butler@amec.com

Knox County Multi-jurisdictional Local Hazard Mitigation Plan

1. Review the six categories of mitigation actions being considered in the Knox County Multi-Jurisdictional Local Hazard Mitigation Plan. Please place a check ☒ next to the four types of mitigation actions that you think should have the highest priority.

☐ **Prevention**: Administrative or regulatory actions/processes that influence the way land and buildings are developed and built.
- Planning and zoning
- Building codes
- Capital improvement programs
- Open space preservation
- Stormwater management regulations

☐ **Property Protection**: Actions that involve the modification of existing buildings or structures to protect them from a hazard or removal from the hazard area.
- Acquisition, Relocation
- Elevation
- Floodproofing
- Structural retrofits
- Storm shutters
- Firewise construction

☐ **Public Education and Awareness**: Actions to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigate them.
- Outreach projects (mailings, media, web)
- Real estate disclosure
- Hazard maps
- Education programs (children and adults)

☐ **Natural Resource Protection**: Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems.
- Erosion and sediment control
- Stream corridor restoration
- Watershed management
- Forest and vegetation management
- Wetland restoration and preservation

☐ **Structural Projects**: Actions that involve the construction of structures to reduce the impact of a hazard.
- Detention/retention structures
- Sediment basins/Low-head weirs
- Culvert resizing/replacement
- Floodwalls
- Safe rooms

☐ **Emergency Services**: Actions that protect people and property during and immediately after a disaster or hazard event.
- Protection of critical facilities
- Protection of lifeline utilities
- Warning systems
- Emergency response service

2. The hazards addressed in the Multi-Jurisdictional Local Hazard Mitigation Plan are listed below. Please indicate the level of risk significance, or extent of potential impacts, within the Knox County planning area that you perceive for each hazard. Please rate EACH hazard 1 through 3 as follows: 1=Low Significance, 2=Moderate Significance, 3=High Significance.

☐ Dam Failure
☐ Drought
☐ Earthquake
☐ Expansive soils
☐ Extreme Temperatures
☐ Flood
☐ Landslides
☐ Land Subsidence and sinkholes
☐ Severe Storms
☐ Tornado
☐ Wildfires
☐ Winter Storms

3. Please comment on any other issues that the planning committee should consider in developing a strategy to reduce future losses caused by hazard events (use back if needed).

amec

8. Press Release Announcing Final Public Comment Period

Knox County, Tennessee
PRESS RELEASE

Knox County Planning Committee Seeks Public Input

Knox County, TN—The public is encouraged to review and comment on the Knox County Multi-jurisdictional Local Hazard Mitigation Plan before it is finalized. This plan was created to develop a strategy to reduce losses to communities from damage caused by natural hazard events.

Taxpayers pay billions of dollars each year for disaster recovery. Some events are predictable, and often, damages can be reduced or eliminated. The federal Disaster Mitigation Act of 2000 requires communities to develop an approved local hazard mitigation plan to remain eligible for certain federal funding.

Knox County invited all jurisdictions in the County to work together to develop this plan. The planning committee addressed natural hazards—ranging from flooding to landslides, tornados, and winter storms—and considered the impacts of these events on local communities. Based on the results of a risk assessment of the hazards, committee members suggested ways for their jurisdiction to reduce damages caused by natural events. The committee consulted with AMEC Earth and Environmental, Inc. to assist with the plan development and ensure that the final plan meets federal regulations.

From September 26-30, 2011, the final draft plan will be available for your review at the following locations:

Online at: http://www.knoxcounty.org/stormwater/

In hard-copy at:

Knox County - Stormwater Department
205 West Baxter Avenue
Knoxville, TN 37917

City of Knoxville - Stormwater Management Department of Engineering
400 Main Street – Room 480
Knoxville, TN 37902

Farragut Town Hall
11408 Municipal Center Drive
Farragut, TN 37934

Public comments will be documented by the planning committee, and incorporated into the plan, as appropriate.

The final plan must be approved by the governing body of each participating jurisdiction, the Knox County Commissioners, the State of Tennessee, and FEMA before becoming official.

For more information on this project, contact: Eddy Roberts with the Knox County Stormwater Department at (865) 215-5234.

9. Neighboring jurisdictions and other key stakeholders invited to comment

Anderson County	paynkey@hotmail.com
Blount County	bastinnett@blounttn.org
Grainger County	jcjjatkins@charter.net
Jefferson County	jcema@charter.net
Loudon County	dhsmith@loudoncounty-tn.gov
Roane County	rheaema@volstate.net
Servier County	jmathews@seviercountytn.org
Tennessee Dam Safety	Lyle.Bentley@tn.gov
Tennessee Emergency Management Agency	ops@tnema.org
Union County	ucems301@comcast.net
University of Tennessee-Knoxville	rmbennett@utk.edu
University of Tennessee-Knoxville	jbeavers@utk.edu

APPENDIX C:
MITIGATION ACTION ALTERNATIVES

Knox County, Tennessee Multi-Jurisdictional Local Hazard Mitigation Plan

Action Ideas

Mitigation Action Idea
Flooding
Install Additional Flood Guages and Flood Warning System
Protect or relocate floodprone critical facilities
Purchase floodprone properties--especially repetitive loss properties
Removal of debris from floodway, stormwater systems, and sinkholes to mitigate floodwater back-up
Upgrade/Expand/Improve Stormwater Management Systems
Create and train volunteer sandbagging brigade
Create and train volunteer search & rescue teams for flood rescues
Develop/improve early warning system/work with media outlets
Early Warning to hospitals and other critical facilities of impending hazard threats
Develop outdoor warning siren network
Real-time flood monitoring on rivers
Elevate floodpone properties
Flood Detention Basins
Elevate low water crossings
Bank Stabilization
Ring levee to protect specific facility
Elevate electrical/mechanical components
Retrofit water/wastewater facilities to withstand flooding
Severe Storms
Adopt/Enforce code to bury utility lines in future development
Adopt/Implement/Enforce building code standard for the installation of lightning protection systems
Create redundancy in utility distribution lines (loops) and key equipment at production facilities
Develop and Implement a Utility Line Clearance Program (like Tree City USA)
Install additional lightning arrestors on power infrastructure
Public Education use of ground outlets and surge protectors in homes and businesses.
Public Education--hailstorm damage prevention
Public Education--promote NOAA weather radios
Public Education--shelter locations
Back-up power for critical facilities
County-wide Reverse 911 system, (Code Red)
Install Generators in school buildings
Retrofit electric lines/poles/conductors to withstand high winds
Dam Failure
Coordinate to ensure regular dam maintenance
Develop and Enforce building restrictions in dam inundation areas
Request Emergency Action Plans for High and Significant Hazard dams w/ potential impact to Knox Co. to include Inundation Maps and Notification in the event of failure, notify the public in dam break inundation areas ahead of time regarding the potential risk
Recommend inclusion of agricultural ponds in state dam safety program
Develop/improve early warning system/work with media outlets
Early Warning to hospitals and other critical facilities of impending hazard threats
Expand/Improve outdoor warning siren network
Prepare Evacuation Plans
Drought
Develop a Standard drought management plan
Public Education--drought impacts on tree roots and preventative measures to take
Promote Crop Insurance
Earthquakes
Develop/Enforce building codes that would prevent damage from earthquake
Develop a coordinated set of mitigation actions that address geological hazards (earthquakes, sinkholes, and landslides).
Earthquake tie-downs of large furniture/bookcases in schools and daycares
Sinkholes
Identify and map specific underground void space areas prone to collapse failure and limit future development in these areas
Implement "critical lot" designations based on soil conditions, slope, and presence of sinkholes
Develop a coordinated set of mitigation actions that address geological hazards (earthquakes, sinkholes, and landslides).

Landslides
Identify potential landslide areas and restrict development in these identified areas. Water redirection and specific planting of deep root vegetation to mitigate landslide
Develop a coordinated set of mitigation actions that address geological hazards (earthquakes, sinkholes, and landslides).
landslide stabilization projects
Expansive Soils
Implement "critical lot" designations based on soil conditions
Determine the feasibility of installing hydraulic barriers or physical restraints to prevent the entry of water into expansive soils.
Extreme Temperatures
Public Education safety during extreme temperatures heat/cold conditions
Public Education-Energy Consumption during extreme heat events, cooling center locations, free fan programs
Public Education--home improvement programs to conserve water and electricity usage to help eliminate hardship on the infrastructure and lower consumption during peak demand. HVAC, window, and insulation programs could deter problems with the elderly (i.e.Green Impact Zone project by KCPL)
Add electric substation transformer switching devices for flexibility in controlling peak load and extreme heat outages
Identify and publish locations of existing cooling centers
Winter Storms
Public Education--winter weather driving
Implement usage of electronic signs on highways to notify motorists of weather warnings
Retrofit electric lines/poles/conductors to withstand snow/ice
Generators for critical facilities
Tornado
Require more tornado drills in public buildings
Public Education-tornado safety
Adopt building codes to require safe rooms in residential structures and public buildings--including schools
Saferoom construction in schools, public buildings, and other locations as identified.
Develop early warning system/work with media outlets
Early Warning to hospitals and other critical facilities of impending hazard threats
Develop outdoor warning siren network
Implement usage of electronic signs on highways to notify motorists of weather warnings
Evaluate existing shelter locations in schools and public buildings (utilizing checklist in FEMA 361)
Identify and publish locations of existing shelters
Promote NOAA Weather Radios
Wildfires
Conduct controlled burns in rural areas to mitigate wildfire
Develop/Implement/Enforce codes to mow high grass and weeds to reduce the potential for wildfires in increased fuel load (brush)areas
Develop/improve early warning system/work with media outlets
Early Warning to hospitals and other critical facilities of impending hazard threats
Conduct a pilot wildfire vulnerability study
Obtain firefighter training specific to wildfires
Conduct homeowner education on placement/clearance of vegetation to mitigate wildfire
NFIP Compliance
Continued Compliance with the National Flood Insurance Program
Review existing building permit procedures and revise as needed to ensure compliance with NFIP
Initiate activities to improve NFIP Community Rating System rating
Conduct agent/lender workshops in support of NFIP efforts
Promote availability of NFIP flood insurance

APPENDIX D: ADOPTION RESOLUTIONS

RESOLUTION NO. R-122-2012

RESOLUTION

A RESOLUTION OF THE COUNCIL OF THE CITY OF KNOXVILLE TO ADOPT THE KNOX COUNTY, CITY OF KNOXVILLE AND TOWN OF FARRAGUT MULTI-JURISDICTIONAL LOCAL HAZARD MITIGATION PLAN.

RESOLUTION NO: R-122-2012

REQUESTED BY: Engineering
PREPARED BY: Law

APPROVED: 05-01-2012

APPROVED AS AN EMERGENCY MEASURE: _____

MINUTE BOOK: 76 PAGE _____

WHEREAS, the City of Knoxville, Knox County and the Town of Farragut, along with assistance from AMEC Earth and Environmental, Homeland Security, and Emergency Management, prepared the Knox County, City of Knoxville and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan to reduce future losses to the county and its communities resulting from natural hazards; and

WHEREAS, the Plan was prepared pursuant to the requirements of the Disaster Mitigation Act of 2000 and to achieve eligibility for the Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance Grant Programs; and

NOW, THEREFORE, BE IT RESOLVED BY THE COUNCIL OF THE CITY OF KNOXVILLE:

SECTION 1: The Council of the City of Knoxville hereby adopts the Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan attached hereto as Exhibit A.

SECTION 2: This Resolution shall take effect from and after its passage, the welfare of the City requiring it.

Madeline Rogero
Presiding Officer of the Council

Cindy Mitchell
Recorder

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RESOLUTION

A RESOLUTION OF THE COMMISSION OF KNOX COUNTY, TENNESSEE, ADOPTING THE KNOX COUNTY, CITY OF KNOXVILLE, AND TOWN OF FARRAGUT MULTI-JURISDICTIONAL LOCAL HAZARD MITIGATION PLAN.

RESOLUTION: R-12-2-410

REQUESTED BY: ENGINEERING & PUBLIC WORKS

PREPARED BY: KNOX COUNTY LAW DIRECTOR'S OFFICE

APPROVED AS TO FORM AND CORRECTNESS: _____ DIRECTOR OF LAW

APPROVED: 2-27-12 DATE

VETOED: _____ DATE

VETO OVERRIDE: _____ DATE

MINUTE BOOK _____ PAGE _____

WHEREAS, Knox County recognizes the threat that natural hazards pose to people and property within our community; and

WHEREAS, undertaking hazard mitigation actions will reduce the potential for harm to people and property from future hazard occurrences; and

WHEREAS, the U.S. Congress passed the Disaster Mitigation Act of 2000 ("Disaster Mitigation Act") emphasizing the need for pre-disaster mitigation of potential hazards; and

WHEREAS, the Disaster Mitigation Act made available hazard mitigation grants to state and local governments; and

WHEREAS, an adopted Local Hazard Mitigation Plan is required as a condition of future funding for mitigation projects under multiple FEMA pre- and post-disaster mitigation grant programs; and

WHEREAS, Knox County fully participated in the FEMA-prescribed mitigation planning process to prepare this Multi-Jurisdictional Local Hazard Mitigation Plan; and

WHEREAS, the Tennessee Emergency Management Agency and the Federal Emergency Management Agency Region IV officials have reviewed the "Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan," and approved it contingent upon this official adoption of the participating governing body; and

WHEREAS, Knox County desires to comply with the requirements of the Disaster Mitigation Act and to augment its emergency planning efforts by formally adopting the Knox County Multi-Jurisdictional Local Hazard Mitigation Plan; and

WHEREAS, adoption by the governing body for Knox County demonstrates the jurisdictions' commitment to fulfilling the mitigation goals and objectives outlined in this Multi-Jurisdictional Local Hazard Mitigation Plan; and

WHEREAS, adoption of this legitimizes the plan and authorizes responsible agencies to carry out their responsibilities under the plan.

NOW THEREFORE BE IT RESOLVED BY THE COMMISSION OF KNOX COUNTY AS FOLLOWS:

The Commission of Knox County hereby adopts the "Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan" as an official plan.

BE IT FURTHER RESOLVED, that Knox County will submit this Adoption Resolution to the Tennessee Emergency Management Agency and Federal Emergency Management Agency Region IV officials to enable the plan's final approval.

BE IT FURTHER RESOLVED, that if any notifications are to be made to effectuate this Resolution, then the County Clerk is hereby requested to forward a copy of this Resolution to the proper authority.

BE IT FURTHER RESOLVED, that this Resolution is to take effect from and after its passage, as provided by the Charter of Knox County, Tennessee, the public welfare requiring it.

Michael Hammond 2-27-12
Presiding Officer of the Commission Date

Foster O. Kelly 2-28-12
County Clerk Date

Approved: [signature] 3/7/12
County Mayor Date

Vetoed: _____
County Mayor Date

APPENDIX E:
REVISIONS TO THE PLAN

CITY OF KNOXVILLE
ENGINEERING DEPARTMENT
MEMORANDUM

DATE: October 7, 2013

TO: City council

FROM: James R. Hagerman, P.E., Director of Engineering

SUBJECT: **NOTIFICATION OF AN UPDATE TO THE MULYI-JURISDICTIONAL LOCAL HAZARD MANAGEMENT PLAN**

The City of Knoxville, Knox County and the Town of Farragut developed the Multi-Jurisdictional Local Hazard Mitigation Plan in 2011 to reduce or eliminate long-term risk to people and property from natural hazards. This plan replaces the Flood Management Plan, previously completed in 2005, which is a requirement of The City of Knoxville due to the number of repetitive Federal Emergency Management Agency (FEMA) flood insurance claims made within the Knoxville Community. This plan also gives Knoxville eligibility for FEMA Hazard Mitigation Assistance Grant programs. As part of that plan, and to maintain flood insurance for the citizens, the Hazard Mitigation Planning Committee is required to update this plan on an annual basis. This is the first update to the plan.

The changes made to the plan were recommendations made by the Hazard Mitigation Planning Committee in a committee meeting on 9/24/2013. The following is a list of the general changes that were made to the plan:

- Updated the members of the Hazard Mitigation Planning Committee where members have had a change in employment and are no longer available
- Updated Effective FIRM Date to reflect recent map revisions.
- Updated Appendix D with adopted resolutions.
- General Housekeeping – updated spelling, grammar and clarifications where needed

If you have any questions regarding this Plan, please contact Brent Johnson, P.E. at 215-2148.

Enclosure: Updated Flood Management Plan

cc: Brently J. Johnson, P.E., R.L.S., Engineering Planning Chief
David B. McGinley, P.E., Stormwater Engineer IV

Knox Co Hazard Mitigation 9-29-13

	Name	Title	Phone
1	David McGinley	SE IV	865-215-2148
2	Darryl Smith	Town Engineer	986-7057
3	Eddy Roberts	Knox County Eng.	215-5234
4	Jon Livengood	Stormwater Eng	865-215-3145
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