Knox County, City of Knoxville, and Town of Farragut

Multi-Jurisdictional Local Hazard Mitigation Plan

DRAFT

Developed by Knox County, City of Knoxville, and Town of Farragut with professional planning assistance from
Amec Foster Wheeler Environment & Infrastructure, Inc.

Special Thanks and Acknowledgements

Knox County Hazard Mitigation Planning Committee

Name	Representing
McGinley, David	City of Knoxville; Primary Jurisdictional Contact
Roberts, Eddy	Knox County; Primary Jurisdictional Contact
Sparks, David	Town of Farragut; Primary Jurisdictional Contact
Fregeolle, Derek	Knox County Schools; Primary Jurisdictional Contact
Banham, Zach	Town of Farragut
Brink, Jimmy	KGIS
Gill, Erin	City of Knoxville
Granju, Chris	Knox County
Hagerman, David	City of Knoxville
Harnish, Jerry	Rural Metro Fire
Hatfield, Lisa	City of Knoxville
Hathaway, Guy	American Red Cross
Hixenbaugh, David	Knoxville Utilities Board (KUB)
Hose, Bart	Town of Farragut
Ickes, Colin	Knox EMA
Kelly, Dan	MPC
Knoefel, Erick	Rural Metro Fire
Lilly, Randy	Knox County
Mann, Amy	Knox County
Napier, Todd	KCDC
Nations, Dennis	Knox County
Oglesby, Charissa	City of Knoxville
Olsen, Cathy	Knox County
Roberts, Scott	Rural Metro Fire
Saal, Lori	Town of Farragut
Sexton, John	Knox County
Shipley, Mark	Town of Farragut
Stump, Keith	KGIS
Wade, Becky	City of Knoxville
Wasik, Judy	Knox EMA
Weth, Chad	City of Knoxville
Whitehead, Randall	City of Knoxville
Woods, Brian	Rural Metro Fire

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 update 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 to achieve eligibility for the Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance (HMA) programs.

This Local 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
- Knox County Schools

The Knox County, City of Knoxville, and Town of Farragut 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 the planning area, assessed the vulnerability to these hazards, and examined the capabilities in place to mitigate them. The planning area 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:

- **Goal 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.**

- **Goal 2: Increase citizen awareness and preparedness by providing information describing all types of hazards, methods for preventing damage, and how to respond.**

- **Goal 3: Strengthen protection of critical facilities and infrastructure from natural hazards to create a safer, more sustainable community.**

To meet the identified goals, the plan recommends the mitigation actions summarize in the table on the following pages. The HMPC also 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 provided in Chapter 4.

The *Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan* has been formally adopted by the associated City and County Commissions and will be updated within a five-year time frame.

Table I. Mitigation Action Matrix

Action	HMPC Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
Real estate disclosure to buyer of drainage easement maintenance responsibility. (Also, detention ponds, low impact development practices, etc.) Realtors Board, all governing agencies	High	2	Flood	✓		✓
Develop outreach/public education program to address excessive heat, sheltering options, and information on reducing agricultural losses	High	2	Extreme Temperature Drought	✓		
Develop MOU for sharing community resources, in addition existing emergency response resources and capabilities.	High	1	Multi-Hazard	✓		
Research opportunities to implement more stringent requirements for low-impact development practices for new and redevelopment projects	High	1	Flood		✓	✓
Research potential for including additional departments/disciplines in the development review process, such as stream determination, historic flooding, soil scientist, geologist/sinkhole review, and environmental review standards	High	1	Flood Expansive Soils		✓	✓
Research options for development BMPs to reduce urban heat island effect	High	1	Extreme Temperature	✓	✓	
Implement Firewise program in areas identified at risk.	High	1	Wildfire	✓	✓	
Research options for requiring and enforcing the recommendations of the Hillside and Ridgetop Protection Plan.	High	1	Landslide	✓	✓	
Continue roadway ditch maintenance to reduce roadway flooding, i.e. Concord Park on Northshore Drive.	High	1	Flood	✓		✓
Research options to increase funding for home weatherization, with priority of vulnerable population through the Weatherization Assistance Program and the Knoxville-Knox County Community Action Committee.	High	1	Extreme Temperature	✓		
Maintain up-to-date building codes with transition to 2018 ICC Code Suite	High	1	Earthquake	✓	✓	✓
Research potential to provide incentives for development outside of environmentally sensitive areas	High	1	Multi-Hazard		✓	✓

Action	HMPC Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
Amplify outreach/public education to encourage participation in Reverse 911 system.	Medium	2	Multi-Hazard	✓		
Create and/or update existing KEMA fact sheets for natural hazards to define hazard risks and suggest personal mitigation actions.	Medium	2	Multi-Hazard	✓		
Provide educational workshop and/or informational materials for the real estate industry including buyers, agents, and lenders.	Medium	2	Multi-Hazard	✓		✓
Develop outreach/public education program for defensible space for wildfire	Medium	2	Wildfire	✓		
Pursue funding for back-up power generators for identified critical facilities and infrastructure.	Medium	3	Multi-Hazard	✓		
Review fuel supply and storage capabilities at critical facilities to ensure continuity of operations during a hazard event.	Medium	3	Multi-Hazard	✓		
Review potential for enhancement to existing warning system(s); identify methods for targeting vulnerable populations	Medium	1	Multi-Hazard, Floods	✓		
Implement and Maintain the Knoxville-Knox County Excessive Heat Plan seeking partners to add/refine response options and incorporating public comment and participation	Medium	1	Extreme Temperature	✓	✓	
Encourage underground utilities for new development and as a retrofit for redevelopment.	Medium	1	Severe Storms, Tornado		✓	
Continue participation in the National Flood Insurance Program (NFIP)	Medium	1	Flood	✓	✓	✓
Participate in the NIFP Community Rating System (CRS) users group, seeking continued improvement in CRS rating	Medium	1	Flood	✓	✓	✓
Review opportunities to regulate private maintenance of stormwater systems conveyance and storage	Medium	1	Flood	✓	✓	✓
Research options to develop open space preservation policy, especially in streamside areas	Medium	1	Flood Extreme Temperature	✓	✓	✓
Develop prioritization strategy for performing watershed assessments	Medium	1	Flood	✓	✓	✓
Create a potential wetlands map	Medium	1	Flood		✓	
Maintain stormwater infrastructure mapping in coordination with neighboring jurisdictions	Medium	1	Flood	✓	✓	✓
Expand the Environmental Stewardship Program (ESP)	Medium	1	Flood	✓	✓	✓

Action	HMPC Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
Develop sinkhole mapping using LiDAR	Medium	1	Sinkhole	✓	✓	✓
Seek to identify and/or prioritize locations for community shelters for mobile home parks/manufactured housing. Secure funding for construction.	Medium	1	Severe Storms, Tornado	✓		
Develop pro-active stormwater and/or public works maintenance program for stormwater infrastructure, including preventative culvert inspections and repair	Medium	1	Flood	✓		✓
Research potential to provide incentives for development outside of environmentally sensitive areas	Medium	1	Multi-Hazard		✓	✓
Secure funding for roadway improvement projects that protect roadways from repetitive flooding	Medium	3	Flood	✓	✓	✓
Replacement of undersized stormwater drainage pipes as identified through flash flooding events, local drainage complaints, and future watershed studies.	Medium	1	Flood	✓	✓	✓
Secure funding for uninterruptible power supply battery-backup systems for traffic signals	Low	1	Multi-Hazard	✓		
Create incentives to correct water utilities for drought	Low	1	Drought	✓	✓	
Increase powerline maintenance to reduce instances of falling trees on powerlines and poles.	Low	1	Severe Storms, Tornado	✓		
Research regulations and process to require storm saferoom construction in all new public buildings	Low	3	Severe Storms, Tornado		✓	
Prioritize and secure funding for buyout of repetitive flood properties	Low	1	Flood	✓		✓
Secure funding for protection and/or relocation of flood-prone critical facilities	Low	3	Flood	✓		✓
First Creek Improvements – 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.	Low	1	Flood	✓	✓	✓

TABLE OF CONTENTS

Chapters

Appendices

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 A. A model resolution is provided.*

MODEL RESOLUTION

Resolution # ______ **Adopting the Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard**

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, 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, 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, City of Knoxville, and Town of Farragut 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, the City of Knoxville, and the Town of Farragut prepared this local hazard mitigation plan update to guide hazard mitigation planning to better protect the people and property of the planning area from the effects of hazard events. This plan update demonstrates the communities' commitment to reducing risks from hazards and serves as a tool to help decision makers direct mitigation activities and resources.

The three goals of the *Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan* are the following:

Goal 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.

Goal 2: Increase citizen awareness and preparedness by providing information describing all types of hazards, methods for preventing damage, and how to respond.

Goal 3: Strengthen protection of critical facilities and infrastructure from natural hazards to create a safer, more sustainable community.

This plan was prepared to ensure Knox County, the City of Knoxville, and the Town of Farragut continued eligibility for certain federal disaster assistance, specifically, the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program, Pre-Disaster Mitigation program, and Flood Mitigation Assistance program. This plan has been prepared in compliance with Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act or the Act), 42 U.S. C. 5165, enacted under Section 104 of the Disaster Mitigation Act of 2000, (DMA 2000) Public Law 106-390 of October 30, 2000, as implemented at CFR 201.6 dated October 2007.

Knox County and the City of Knoxville are also participants in the National Flood Insurance Program's (NFIP) Community Rating System (CRS) and, having more than 10 repetitive loss properties, are required to prepare and maintain a floodplain management plan (FPM). This multi-hazard mitigation plan addresses the flood hazard and was developed in accordance with the CRS FPM planning requirements.

The CRS program recognizes and encourages community floodplain management activities that exceed the minimum requirements of the NFIP. Under the CRS program, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from community activities that (1) reduce flood losses, (2) facilitate accurate insurance ratings, and (3) promote the awareness of flood insurance.

Knox County entered the CRS program in 2002 and currently qualifies for a class 9 rating. With the class 9 rating, citizens of Knox County receive a 5-percent discount on flood insurance premiums. The City of Knoxville entered the CRS program in 1992 and currently qualifies for a class 8 rating. With the class 8 rating, citizens of the City of Knoxville receive a 10-percent discount on flood insurance premiums.

Table 1.1 below presents the relationship of CRS class ratings and insurance premium discounts.

Table 1.1. CRS Classes, Credit Points, and Premium Discounts

CRS Class	Credit Points	Flood Insurance Premium Discount	
		In SFHA[1]	Outside SFHA
1	4.500+	45%	10%
2	4.000-4.499	40%	10%
3	3.500-3.999	35%	10%
4	3.000-3.499	30%	10%
5	2.500-2.999	25%	10%
6	2.000-2.499	20%	10%
7	1.500-1.999	15%	5%
8	1.000-1.499	10%	5%
9	500-999	5%	5%
10	0-499	0%	0%

1 – SFHA, Special Flood Hazard Area; the floodplain delineated on the FIRM as A Zones and V Zones

In addition to reduced flood insurance rates, citizens of Knox County and the City of Knoxville benefit from the CRS program through:

- Enhanced public safety, reduction in damage to property and public infrastructure, avoidance of economic disruption and losses, reduction in human suffering, and protection of the environment provided by the credited flood protection activities.
- Increased outreach activities focused on flood risk enabling citizens to evaluate their individual vulnerabilities, and take action to protect themselves, as well as their homes and businesses.
- Training and technical assistance for Knox County and City of Knoxville staff in designing and implementing credited flood protection activities.

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 the planning area.

The *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 jurisdictions participated in the planning process:

- Knox County
- City of Knoxville
- Town of Farragut
- Knox County Schools

This plan update 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). Because the planning area is subject to many kinds of hazards access to these programs is vital.

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 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 The 10-Step Planning Process

Requirements §201.6(b) and §201.6(c)(1): 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;**
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 nonprofit interests to be involved in the planning process; and**
3) **Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.**

[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.

Knox County, the City of Knoxville, and the Town of Farragut recognized the need and importance of a local hazard mitigation plan and initiated its development. The communities contracted with Amec Foster Wheeler Environment & Infrastructure, Inc. (Amec Foster Wheeler) to facilitate and develop the plan. Amec Foster Wheeler's role was to:

- Assist in establishing the Hazard Mitigation Planning Committee (HMPC) as defined by the Disaster Mitigation Act (DMA);
- Meet the DMA requirements as established by federal regulations and following FEMA's planning guidance;
- Support objectives under the National Flood Insurance Program's Community Rating System and the Flood Mitigation Assistance program,
- 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 plan reviews with the Tennessee Emergency Management Agency (TEMA) and FEMA Region IV.

Amec Foster Wheeler established the planning process for the *Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan Update* using the DMA planning requirements and FEMA's associated guidance. This guidance is structured around a four-phase process:

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

Into this process, a more detailed 10-step planning process used for FEMA's Community Rating System (CRS) and Flood Mitigation Assistance programs was integrated. Thus, the modified 10-step process used for this plan meets the requirements of five major programs: FEMA's Hazard Mitigation Grant Program, Pre-Disaster Mitigation program, Community Rating System, Flood Mitigation Assistance Program, and new flood control projects authorized by the U.S. Army Corps of Engineers.

Table 1.2 shows how the CRS 10-step process fits into FEMA's four-phase process.

Table 1.2. Mitigation Planning Processes Used to Update the *Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan*

FEMA 4 Phase Guidance	FEMA Local Mitigation Planning Handbook Tasks (44 CFR Part 201)	Community Rating System (CRS) Planning Steps (Activity 510)
Phase I Organize Resources	Task 1: Determine the Planning Area and Resources	Step 1. Organize to Prepare the Plan
	Task 2: Build the Planning Team 44 CFR 201.6(c)(1)	
	Task 3: Create an Outreach Strategy 44 CFR 201.6(b)(1)	Step 2. Involve the public
	Task 4: Review Community Capabilities 44 CFR 201.6(b)(2) & (3)	Step 3. Coordinate with Other Agencies
Phase II Assess Risks	Task 5: Conduct a Risk Assessment 44 CFR 201.6(c)(2)(i) 44 CFR 201.6(c)(2)(ii) & (iii)	Step 4. Assess the hazard(s)
		Step 5. Assess the problem(s)
Phase III Develop a Mitigation Plan	Task 6: Develop a Mitigation Strategy 44 CFR 201.6(c)(3)(i); 44 CFR 201.6(c)(3)(ii); and 44 CFR 201.6(c)(3)(iii)	Step 6. Set goals
		Step 7. Review possible activities
		Step 8. Draft an action plan
Phase IV Implement the Plan and Monitor Progress	Task 8: Review and Adopt the Plan	Step 9. Adopt the plan
	Task 7: Keep the Plan Current	Step 10. Implement, evaluate, revise
	Task 9: Create a Safe and Resilient Community 44 CFR 201.6(c)(4)	

Source: Local Mitigation Planning Handbook, FEMA, March 2013; NFIP CRS Coordinator's Manual, 2013

1.3.1 Phase 1: Organize Resources

Planning Step 1: Organize to Prepare the Plan

With Knox County, the City of Knoxville, and the Town of Farragut's commitment to participate in the DMA and CRS planning process, jurisdictional representatives worked to establish the framework and organization for development of the plan. An initial meeting was held with jurisdictional representatives to discuss the organizational aspects of the plan development process.

Invitations to participate on the Hazard Mitigation Planning Committee (HMPC) were extended to City, County, and Town officials, citizens, and federal, state, and local stakeholders that might have an interest in participating in the planning process. The list of final HMPC members is included in Appendix B. The following is a list of departments and organizations represented on the HMPC:

Knox County

- Codes Administration and Enforcement
- Engineering & Public Works
  - Stormwater Management
  - Transportation
  - Planning & Development
- Emergency Management Agency
- GIS Administration

City of Knoxville

- Community Development
- Engineering
- Emergency Management Agency
- Knoxville's Community Development Corporation (KCDC)
- Law
- Public Service
- Sustainability

Town of Farragut

- Community Development
- Engineering

Knox County Schools

- Security

Local Stakeholder Representatives

- American Red Cross
- Rural Metro Fire

- Knoxville Utility Board (KUB)
- Knoxville, Knox County, Knoxville Utilities Board Geographic Information System
- Knoxville-Knox County Metropolitan Planning Commission

The DMA planning regulations and guidance stress that each local government seeking FEMA approval of their mitigation plan must participate in the planning effort in the following ways:

- Participate in the process as part of the HMPC;
- Detail areas within the planning area where the risk differs from that facing the entire area;
- Identify potential mitigation actions; and
- Formally adopt the plan.

For Knox County, the City of Knoxville, and Town of Farragut and the HMPC, “participation” meant the following:

- Attending and participating in the HMPC meetings;
- Providing requested data (as available);
- Reviewing and providing comments on plan drafts;
- Advertising, coordinating, and participating in the public input process; and
- Coordinating the formal adoption of the plan by the governing boards.

The planning process officially began with a kick-off meeting on July 11, 2017, held at the Knoxville Public Works Service Center. The meeting covered the scope of work and an introduction to the DMA requirements. The HMPC continued to communicate 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 and jurisdictional participation is presented in Table 1.4. The sign-in sheets and meeting minutes for each of the meetings are included in Appendix B.

Table 1.3. Schedule of HMPC Meetings

Meeting	Topic	Date
Coordination	Coordination Meeting with Knox County, the City of Knoxville, and the Town of Farragut to prepare for project kick-off and identify HMPC members.	June 1, 2017
HMPC #1	Kickoff meeting: Review of the hazard mitigation planning process and hazard identification	July 11, 2017
HMPC #2	Review of previous risk assessment; discussion of risk assessment and data needs for plan update; and review of plan goals and objectives	September 26, 2017
HMPC #3	Update mitigation actions and prioritization; discussion of process to monitor, evaluate, and update plan	October 26, 2017

Table 1.4. Jurisdictional Participation

Jurisdiction	Coordination Meeting	HMPC Meeting #1	HMPC Meeting #2	HMPC Meeting #3	Data Collection Guide	Status of Previous Actions	Mitigation Action Plans
Knox County	✓	✓	✓	✓	✓	✓	✓
City of Knoxville	✓	✓	✓	✓	✓	✓	✓
Town of Farragut	✓	✓	✓	✓	✓	✓	✓
Knox County Schools		✓	✓		✓	✓	✓

Based on the area of expertise of each jurisdictional representative participating on the HMPC, Table 1.5 demonstrates each member's expertise in the six mitigation categories (Prevention, Property Protection, Natural Resource Protection, Emergency Services, Structural Flood Control Projects and Public Information). City and County departments are responsible for implementing community land use regulations, comprehensive plans, and other regulations that have an impact on risk and vulnerability within the planning area.

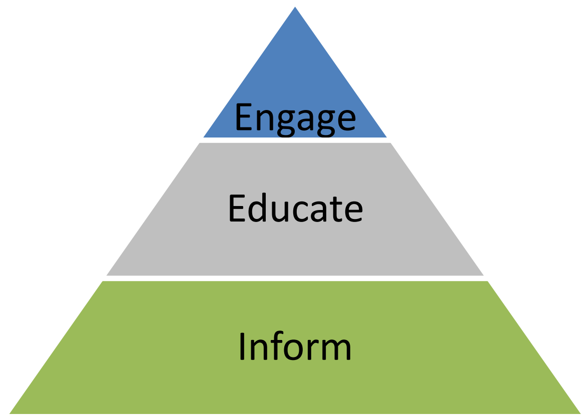
Table 1.5 – HMPC Capability with Six Mitigation Categories

Community Department/Office	Prevention	Property Protection	Natural Resource Protection	Emergency Services	Structural Flood Control Projects	Public Information
Knox County						
Codes Administration and Enforcement	✓	✓	✓			✓
Engineering & Public Works	✓	✓	✓	✓	✓	✓
Emergency Management Agency	✓	✓		✓		✓
GIS Administration	✓	✓	✓		✓	✓
City of Knoxville						
Community Development	✓	✓	✓			✓
Engineering	✓	✓	✓		✓	✓
Emergency Management Agency	✓	✓		✓		✓
Knoxville's Community Development Corporation	✓	✓	✓		✓	✓
Law	✓	✓	✓			✓
Public Service	✓	✓	✓		✓	✓
Sustainability	✓		✓			✓
Town of Farragut						
Community Development	✓	✓	✓		✓	✓
Engineering	✓	✓	✓		✓	✓
Knox County Schools						
Security	✓	✓		✓		✓

Step 2: Plan for Public Involvement

At the kick-off meeting, the HMPC discussed options for public involvement. A public outreach strategy was prepared to capture the input of the HMPC and identify tools and activities to engage, educate, and inform the citizens of Knox County, the City of Knoxville, and the Town of Farragut of local multi-hazard mitigation planning efforts for each of the major phases of the mitigation planning process. This outreach includes:

- **Engage** the public and other stakeholders through interactive dialogue including such forums as planning committee meetings, public meetings, workshops and open house events;
- **Educate** the public and other stakeholders through a listen and learn process such as information booths, presentations, and briefings to elected officials; and
- **Inform** the public and other stakeholders through one-way communication such as written outreach materials, websites, and news media.



ENGAGE

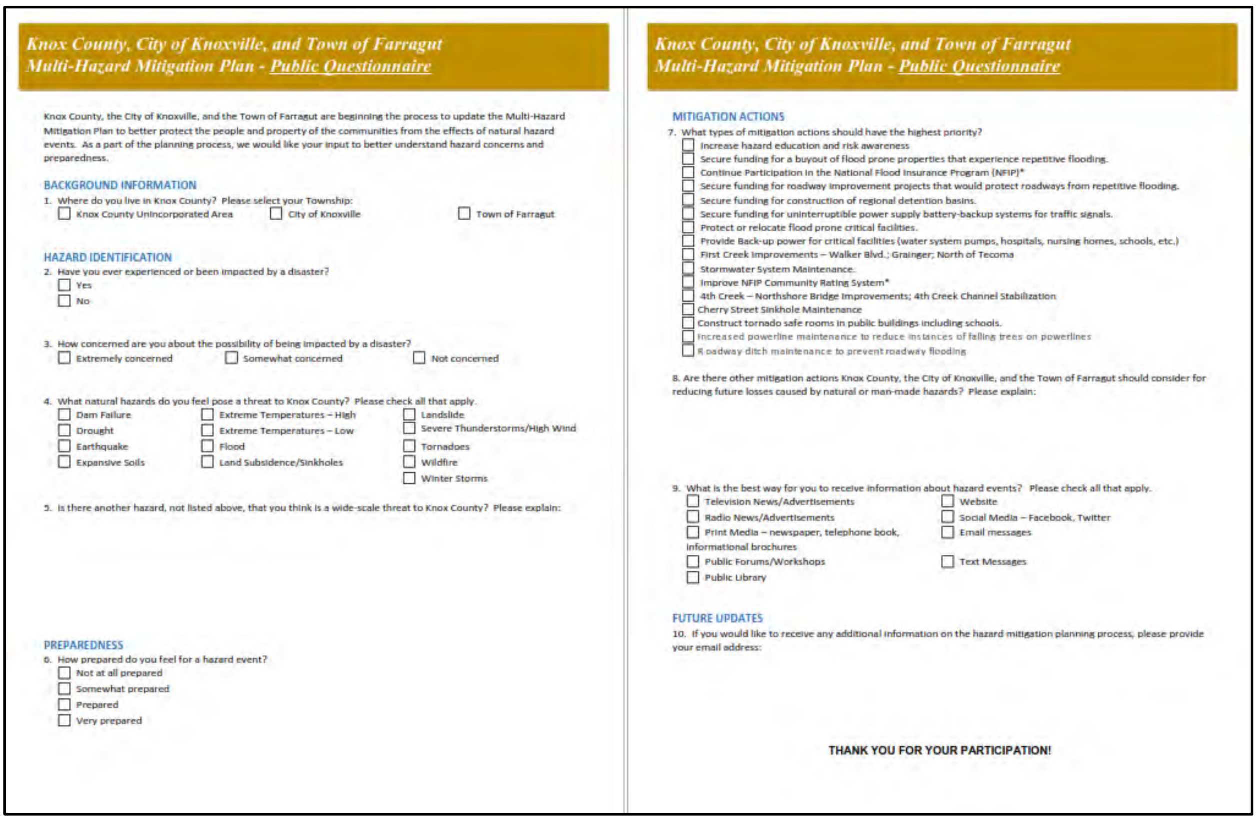
- **Public Meetings -** Two (2) public meetings were held at key points in the project timeline to obtain public input on natural hazards, problems, and possible solutions. The public meetings were held during the draft-plan development and prior to finalizing the plan. Where appropriate, stakeholder and public comments were incorporated into the final plan, including the sections that address mitigation goals and strategies. These meetings were coordinated and arranged by the participating jurisdictions with facilitation support from Amec Foster Wheeler. Meeting dates included:
  - September 26, 2017, Public Works Service Center, Introduction to DMA, CRS, and the planning process. This public meeting was held following the HMPC Meeting #2.
  - October 25, 2017, Public Works Service Center, Open House. This public meeting was held following the HMPC Meeting #3 to gather input from the public and stakeholders on potential mitigation actions.

EDUCATE

- **Presentations/Information Distribution for Stakeholder Groups –** Staff from Knox County, the City of Knoxville, and the Town of Farragut coordinated additional hazard mitigation presentations and/or information distribution to various stakeholder groups to explain the planning process and encourage input to the HMPC.

- **Briefings to Elected Officials –** Staff from Knox County, the City of Knoxville, and the Town of Farragut coordinated one-on-one meetings with elected officials, as requested, to provide updates on the mitigation planning process.
- **Questionnaire -** A public participation questionnaire was prepared by Amec Foster Wheeler using the SurveyMonkey web hosting service and was open to the public for four months, see Figure 1.1. The purpose of this questionnaire was to solicit input from the public and stakeholders in the planning area regarding hazards of concern, areas of mitigation interest, and related preparedness. The online survey gave individuals that were unable to attend the in-person meetings the opportunity to participate in the planning process. The questionnaire was made available through web links posted on community websites, circulated via email, and social media outlets. Additionally, hard copies of the questionnaire were distributed at all public meetings and presentations to stakeholders groups.

Figure 1.1 – Public Questionnaire



Knox County, City of Knoxville, and Town of Farragut
Multi-Hazard Mitigation Plan - Public Questionnaire

Knox County, the City of Knoxville, and the Town of Farragut are beginning the process to update the Multi-Hazard Mitigation Plan to better protect the people and property of the communities from the effects of natural hazard events. As a part of the planning process, we would like your input to better understand hazard concerns and preparedness.

BACKGROUND INFORMATION

1. Where do you live in Knox County? Please select your Township:
   - ☐ Knox County Unincorporated Area ☐ City of Knoxville ☐ Town of Farragut

HAZARD IDENTIFICATION

2. Have you ever experienced or been impacted by a disaster?
   - ☐ Yes
   - ☐ No
3. How concerned are you about the possibility of being impacted by a disaster?
   - ☐ Extremely concerned ☐ Somewhat concerned ☐ Not concerned
4. What natural hazards do you feel pose a threat to Knox County? Please check all that apply.
   - ☐ Dam Failure ☐ Extreme Temperatures – High ☐ Landslide
   - ☐ Drought ☐ Extreme Temperatures – Low ☐ Severe Thunderstorms/High Wind
   - ☐ Earthquake ☐ Flood ☐ Tornadoes
   - ☐ Expansive Soils ☐ Land Subsidence/Sinkholes ☐ Wildfire
   - ☐ Winter Storms
5. Is there another hazard, not listed above, that you think is a wide-scale threat to Knox County? Please explain:

PREPAREDNESS

6. How prepared do you feel for a hazard event?
   - ☐ Not at all prepared
   - ☐ Somewhat prepared
   - ☐ Prepared
   - ☐ Very prepared

Knox County, City of Knoxville, and Town of Farragut
Multi-Hazard Mitigation Plan - Public Questionnaire

MITIGATION ACTIONS

7. What types of mitigation actions should have the highest priority?
   - ☐ Increase hazard education and risk awareness
   - ☐ Secure funding for a buyout of flood prone properties that experience repetitive flooding.
   - ☐ Continue Participation in the National Flood Insurance Program (NFIP)*
   - ☐ Secure funding for roadway improvement projects that would protect roadways from repetitive flooding.
   - ☐ Secure funding for construction of regional detention basins.
   - ☐ Secure funding for uninterruptible power supply battery-backup systems for traffic signals.
   - ☐ Protect or relocate flood prone critical facilities.
   - ☐ Provide Back-up power for critical facilities (water system pumps, hospitals, nursing homes, schools, etc.)
   - ☐ First Creek Improvements – Walker Blvd.; Grainger; North of Tecoma
   - ☐ Stormwater System Maintenance.
   - ☐ Improve NFIP Community Rating System*
   - ☐ 4th Creek – Northshore Bridge Improvements; 4th Creek Channel Stabilization
   - ☐ Cherry Street Sinkhole Maintenance
   - ☐ Construct tornado safe rooms in public buildings including schools.
   - ☐ Increased powerline maintenance to reduce instances of falling trees on powerlines
   - ☐ Roadway ditch maintenance to prevent roadway flooding

8. Are there other mitigation actions Knox County, the City of Knoxville, and the Town of Farragut should consider for reducing future losses caused by natural or man-made hazards? Please explain:

9. What is the best way for you to receive information about hazard events? Please check all that apply.
   - ☐ Television News/Advertisements ☐ Website
   - ☐ Radio News/Advertisements ☐ Social Media – Facebook, Twitter
   - ☐ Print Media – newspaper, telephone book, informational brochures ☐ Email messages
   - ☐ Public Forums/Workshops ☐ Text Messages
   - ☐ Public Library

FUTURE UPDATES

10. If you would like to receive any additional information on the hazard mitigation planning process, please provide your email address:

THANK YOU FOR YOUR PARTICIPATION!

INFORM

- **Newspaper Articles –** Staff from Knox County, the City of Knoxville, and the Town of Farragut coordinated public outreach through use of public information officers, press releases, and local media to generate interest and support in the mitigation planning process. Examples include the news story presented by Knox TN Today, an online resource:
  - https://www.knoxtntoday.com/knoxville-farragut-seek-input-hazard-mitigation-plan/

- **Website -** Project information websites were prepared and hosted by Knox County, the City of Knoxville, and the Town of Farragut for the duration of the planning process with the primary purpose to share information relevant to the *Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan*. Specific resources to be included on this site include:
  - Meeting schedule, agendas, presentations, and minutes;
  - Project information flyers for introduction, risk assessment, and notification of draft document;
  - Link to online questionnaire
  - Draft Local Hazard Mitigation Plan Update for review/comment; and
  - Reference documents and links to planning resources.

  The website addresses are:
  - https://www.knoxcounty.org/stormwater/fema_mitigation.php
  - http://www.knoxvilletn.gov/government/city_departments_offices/engineering/stormwater_engineering_division/floodplains

- **Project Information Flyers –** Project information flyers were developed and distributed throughout the planning process to provide information on the hazard mitigation planning and opportunities for public involvement. This resource was available on the project information website as well as distributed to local libraries and at public meetings identified in the 'educate' process. Specific information to be provided in the flyers includes:
  - What is a Hazard Mitigation Plan?
  - Why is it important to me?
  - What can I do to participate?
  - Planning Status
  - Mitigation Success Stories

- **Social Media –** Knox County, the City of Knoxville, and the Town of Farragut's social media outlets on Twitter and Facebook were utilized to publish information regarding public meetings, the online questionnaire, and general hazard mitigation planning information.

Documentation of all public outreach activities is included in Appendix B.

Step 3: Coordinate with Other Departments and Agencies

Early in the planning process, the HMPC determined that data collection, mitigation strategy development, and plan approval would be greatly enhanced by inviting state and federal agencies and organizations to participate in the process. A detailed list of agency coordination is provided above under Planning Step 1: Organize to Prepare the Plan.

In addition, the HMPC reached out to agencies and organizations outside of Knox County. The following agencies and organizations were contacted, initially by formal letter, requesting data or information related to natural and hazards in the planning area and offer the opportunity to participate in the planning process and on the HMPC:

- National Weather Service - Morristown, TN
- U.S. Army Corps of Engineers, Silver Jackets
- National Resource Conservation Service (NRCS)
- FEMA Region IV - Mitigation Planning
- US Fish and Wildlife
- State NFIP Coordinator
- TN - Emergency Management Agency
- TN - Department of Agriculture
- TN - Department of Economic and Community Development
- TN - Environment & Conservation - Air
- TN - Environment & Conservation - Natural Areas
- TN - Environment & Conservation - Sustainable Practices
- TN - Environment & Conservation - Water
- TN - Historic Commission
- TN - Housing Development Agency
- TN - Health Department
- Anderson County Emergency Management Agency
- Union County Emergency Management Agency
- Grainger County Emergency Management Agency
- Jefferson County Emergency Management Agency
- Sevier County Emergency Management Agency
- Blount County Emergency Management Agency
- Loudon County Emergency Management Agency
- Roane County Emergency Management Agency

The agencies and organizations were contacted a second time, by formal letter, requesting review and comment on the Draft Hazard Mitigation Plan Update. The letter templates and list of addresses to which the letters were mailed can be found in Appendix B. Copies of letters sent will be provided upon request.

Other Community Planning Efforts and Hazard Mitigation Activities

Coordination with other community planning efforts is also paramount to the success of this plan. Hazard mitigation planning involves identifying existing policies, tools, and actions that will reduce a community's risk and vulnerability to hazards. Knox County, the City of Knoxville, and the Town of Farragut use a variety of comprehensive planning mechanisms, such as general plans and ordinances, to guide growth and development. Integrating existing planning efforts and mitigation policies and action strategies into this plan establishes a credible and comprehensive plan that ties into and supports other community programs. The development of this plan incorporated information from the following existing plans, studies, reports, and initiatives as well as other relevant data from neighboring communities and other jurisdictions.

- Tennessee State Hazard Mitigation Plan (2013)
- Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan (2011)
- National Flood Insurance Program Policy and Loss Statistics;
- Flood Insurance Administration, Repetitive/Severe Repetitive Loss Property Data;
- Flood Insurance Rate Maps for all of Knox County;
- National Inventory of Dams;
- Wildland/Urban Interface and Intermix areas from the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin;
- Various local plans such as Comprehensive Plans, Economic Development Plans, Capital Improvement Plans, etc. For a complete list of local plans that were reviewed and incorporated, see Chapter 2;
- US Department of Agriculture's (USDA) Risk Management Agency Crop Insurance Statistics

These and other documents were reviewed and considered, as appropriate, during the collection of data to support Planning Steps 4 and 5, which include the hazard identification, vulnerability assessment, and capability assessment. Data from these plans and ordinances were incorporated into the risk assessment and hazard vulnerability sections of the plan as appropriate. The data was also used in determining the capability of the community in being able to implement certain mitigation strategies. The Capability Assessment can be found in Chapter 2.

1.3.2 Phase 2: Assess Risk

Planning Steps 4 and 5: Assess the Hazard(s) and Assess the Problem(s)

Amec Foster Wheeler led the HMPC in an exhaustive research effort to identify and document all the hazards that have, or could, impact the planning area. Geographic information systems (GIS) were used to display, analyze, and quantify hazards and vulnerabilities. The HMPC also conducted a capability assessment to review and document the planning area's current capabilities to mitigate risk and vulnerability from hazards. By collecting information about existing government programs, policies, regulations, ordinances, and emergency plans, the HMPC could assess those activities and measures already in place that contribute to mitigating some of the risks and vulnerabilities identified. A more detailed description of the risk assessment process and the results are included in Chapter 3 Risk Assessment.

1.3.3 Phase 3: Develop a Mitigation Plan

Planning Steps 6 and 7: Set Goals and Review Possible Activities

Amec Foster Wheeler facilitated brainstorming and discussion sessions with the HMPC that described the purpose and the process of developing planning goals and objectives, a comprehensive range of mitigation alternatives, and a method of selecting and defending recommended mitigation actions using a series of selection criteria. This information is included in Chapter 4 Mitigation Strategy. Additional documentation on the process the HMPC used to develop the goals and strategy is in Appendix C: Mitigation Alternatives and Prioritization.

Planning Step 8: Draft an Action Plan

Based on input from the HMPC regarding the draft risk assessment and the goals and activities identified in Planning Steps 6 and 7, Amec Foster Wheeler produced a complete first draft of the plan update. This complete draft was distributed for HMPC review and comment. Other agencies were invited to comment on this draft as well. HMPC and agency comments were integrated into the second draft, which was advertised and distributed to collect public input and comments. Amec Foster Wheeler integrated comments and issues from the public, as appropriate, along with additional internal review comments and produced a final draft for the Tennessee Emergency Management Agency and FEMA Region IV to review and approve, contingent upon final adoption by the participating jurisdictions. All planning document deliverables are outlined in Table 1.6 below.

Table 1.6. Planning Deliverables

Deliverable	Date
Mitigation Planning Kickoff Preparation	June 1, 2017
Introduction for HMPC	June 28, 2017
HMPC #1- Meeting Minutes	July 18, 2017
Public Information Flyer #1	August 15, 2017
Public Outreach Strategy	August 15, 2017
HMPC #2- Meeting Minutes	October 15, 2017
Draft Multi-Hazard Mitigation Plan - Chapter 3 - Mitigation Actions	November 7, 2017
HMPC #3- Meeting Minutes	November 7, 2017
Draft Multi-Hazard Mitigation Plan - Executive Summary - Chapters 1 and 2 - Chapters 4 and 5 - Appendices A, B, C, and D	November 17, 2017
Public Information Flyer #2	February 5, 2017
Draft Multi-Hazard Mitigation Plan for Public Review	February 5, 2017

1.3.4 Phase 4: Implement the Plan and Monitor Progress

Planning Step 9: Adopt the Plan

In order to secure buy-in and officially implement the plan, the plan was adopted by each participating jurisdiction on the date included in the adoption resolution in Appendix A: Adoption Resolution.

Planning Step 10: Implement, Evaluate, and Revise the Plan

The true worth of any mitigation plan is in the effectiveness of its implementation. Up to this point in the planning process, all of the HMPC's efforts have been directed at researching data, coordinating input from participating entities, and developing appropriate mitigation actions. Each recommended action includes key descriptors, such as a lead manager and possible funding sources, to help initiate implementation. An overall implementation strategy is described in Chapter 5 Plan Implementation and Maintenance. A plan update and maintenance schedule and a strategy for continued public involvement are also included in Chapter 5.

Finally, there are numerous organizations within the planning area whose goals and interests interface with hazard mitigation. Coordination with these other planning efforts, as addressed in Planning Step 3, is paramount to the ongoing success of this plan and mitigation in Knox County, the City of Knoxville, and the Town of Farragut and is addressed further in Chapter 5.

2 Planning Area Profile and Capabilities

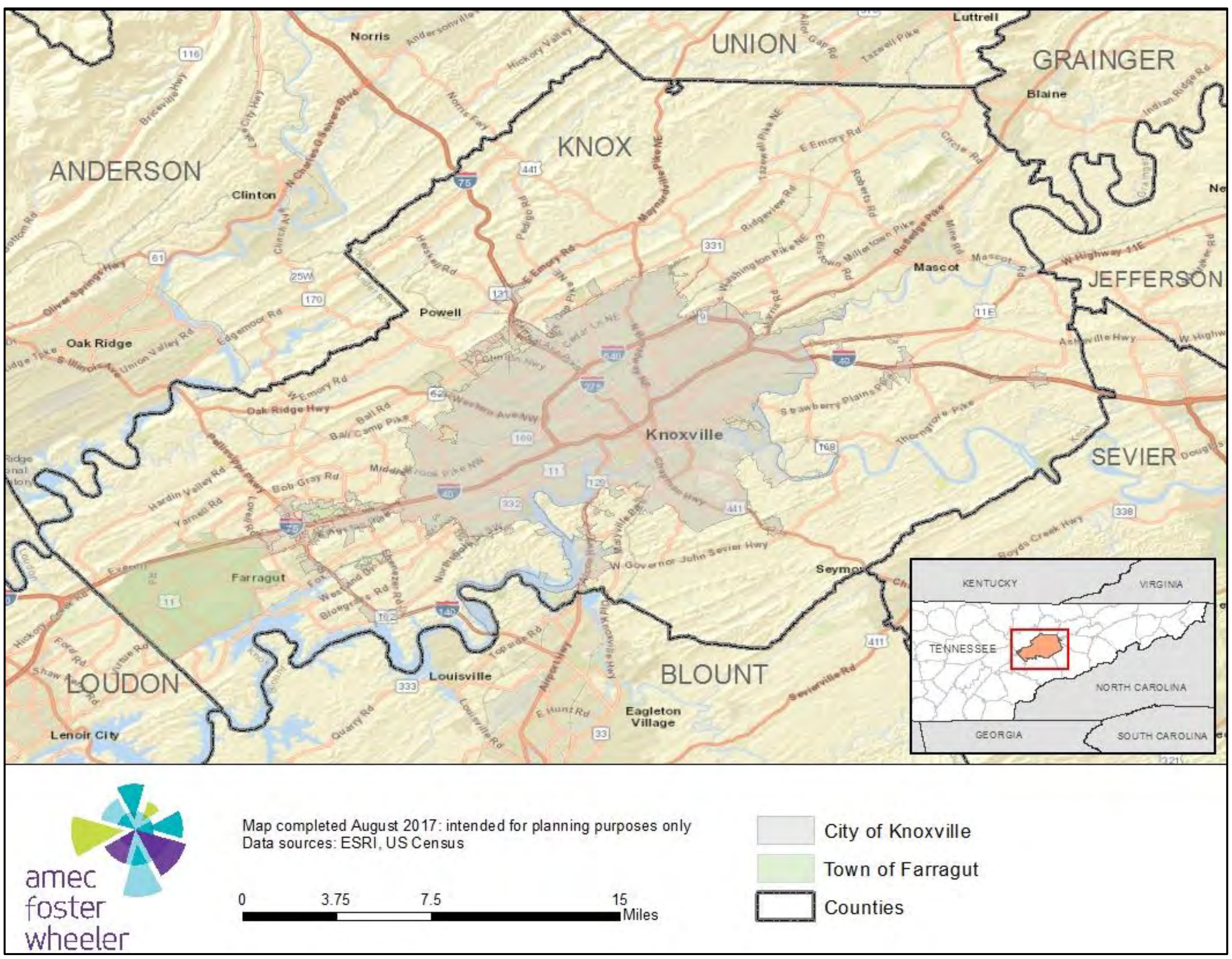
Chapter 2 provides a general profile of Knox County, followed by individual sections for each participating jurisdiction. The sections for each jurisdiction provide an overview profile as well as details on existing capabilities, plans, and programs that enhance their ability to implement mitigation strategies.

2.1 Knox County Planning Area Profile

Figure 2.1 provides a map of the Knox County planning area. The planning area boundaries include the unincorporated areas of Knox County as well as the following incorporated cities:

- City of Knoxville
- Town of Farragut

Figure 2.1 Knox County Planning Area



2.1.1 History

Knox County was established in 1792, four years prior to Tennessee statehood, during which time the area was then known as the Southwest Territory or "Territory South of the River Ohio." Knox County was created from Greene and Hawkins counties. It is one of nine US counties named for an American Revolutionary War General and first US Secretary of War Henry Knox. Parts of Knox County were later carved to form new counties: Blount (1795), Grainger (1796), Anderson (1801), Roane (1801), and Union (1850).

The City of Knoxville was initially established as the James White's Fort on the Trans-Appalachian frontier in 1786. In 1790, the Fort was chosen as the capital of the Southwest Territory. In the following year of 1791, the City was platted and also named for Secretary of War Henry Knox. Knoxville became the first capital of the State of Tennessee in 1796.

The Town of Farragut was incorporated in January 1980, with the first Board of Mayor and Aldermen elected on April 1, 1980. The Town is named after Admiral David Glasgow Farragut, the first admiral of the US Navy, who was born in the Farragut area.

2.1.2 Geography and Topography

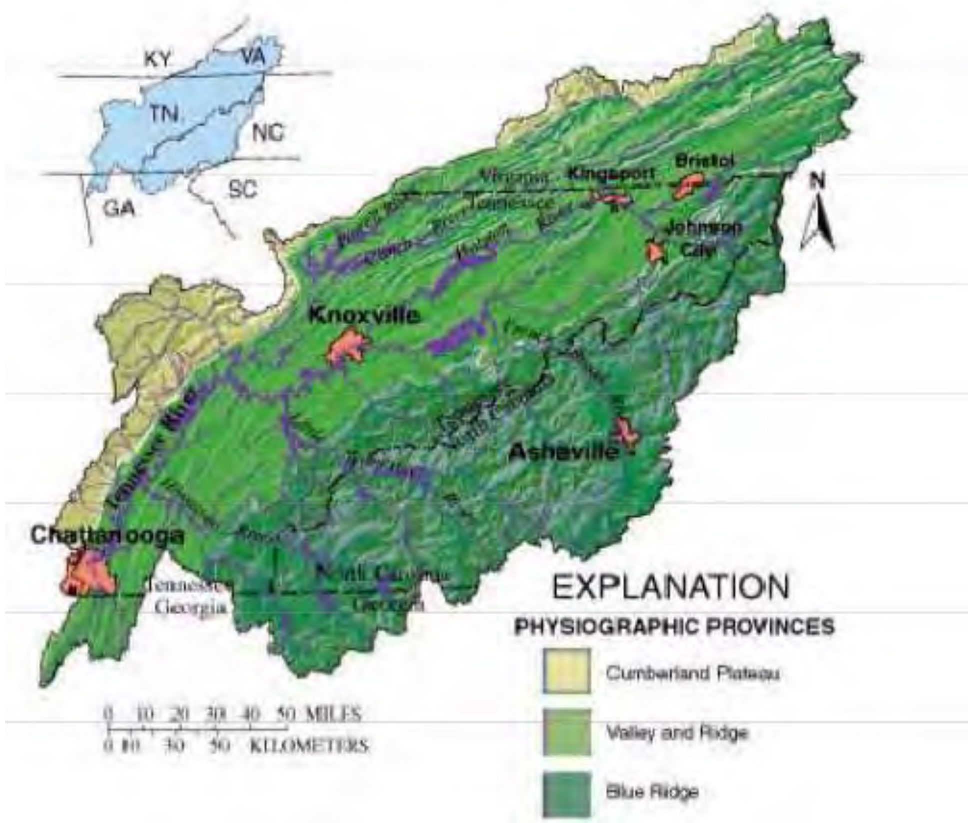
Knox County is located in east central Tennessee, west of the center of the state. Knox County is bounded by eight neighboring counties; on the north by Anderson and Union Counties, on the east by Grainger, Jefferson, and Sevier Counties, on the south by Blount and Loudon Counties, and on the west by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

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. Knox County is located within 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.

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.

Figure 2.2 Upper Tennessee River Basin



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

2.1.3 Climate

Summers are the warmest time of year in Knox County, with the daily average temperature in July at 77.0°F and an average of 31.8 days per year with temperatures reaching 90°F. Winters are generally much cooler and less stable, with occasional small amounts of snow. January has a daily average temperature of 36.9°F, although in most years there is at least one day (average 5.8) where the high remains at or below freezing. The record high for Knoxville is 102°F August 21, 1983 while the record low is −20°F on January 21, 1985. Annual precipitation averages 53 inches and normal seasonal snowfall is 1.3 inches occurring in December, January, February, and March. Table 2.1 presents the monthly climate summaries for Knox County.

Table 2.1 Knox County Monthly Climate Summaries, 1966-2012

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANN
Mean Temperature (°F)	36.9	40.4	48.9	56.9	65.6	73.3	77.0	76.3	69.9	58.1	48.2	39.2	57.6
Average Max Temperature (°F)	47.2	51.5	61.4	69.9	77.5	84.7	87.8	87.5	81.7	71.1	60.4	49.4	69.2
# of Days Max Temp above 90°F	0.0	0.0	0.0	0.0	0.3	5.6	11.6	10.4	3.8	0.0	0.0	0.0	31.8
Average Min Temperature (°F)	26.5	29.3	36.4	43.8	53.6	61.8	66.3	65.1	58.1	45.1	35.9	28.9	45.9
# of Days Min Temp below 32°F	2.7	1.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	5.8
Average Total Precipitation (in)	4.91	4.25	5.20	4.42	4.76	4.24	5.29	3.58	3.77	3.11	4.38	5.19	53.11
Average Total Snowfall (in)	0.8	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.3

Source: Southeast Regional Climate Center; Knoxville EXP STN (#404946) https://www.sercc.com/cgi-bin/sercc/cliMAIN.pl?tn4946

Changing Future Conditions

The Third National Climate Assessment: *Climate Change Impacts in the United States* was published in 2014 by the National Science and Technology Council and the U.S. Global Change Research Program. The report assesses the science of climate change and its impacts across the United States, now and throughout this century. It documents climate change related impacts and responses for various sectors and regions, with the goal of better informing public and private decision-making at all levels.

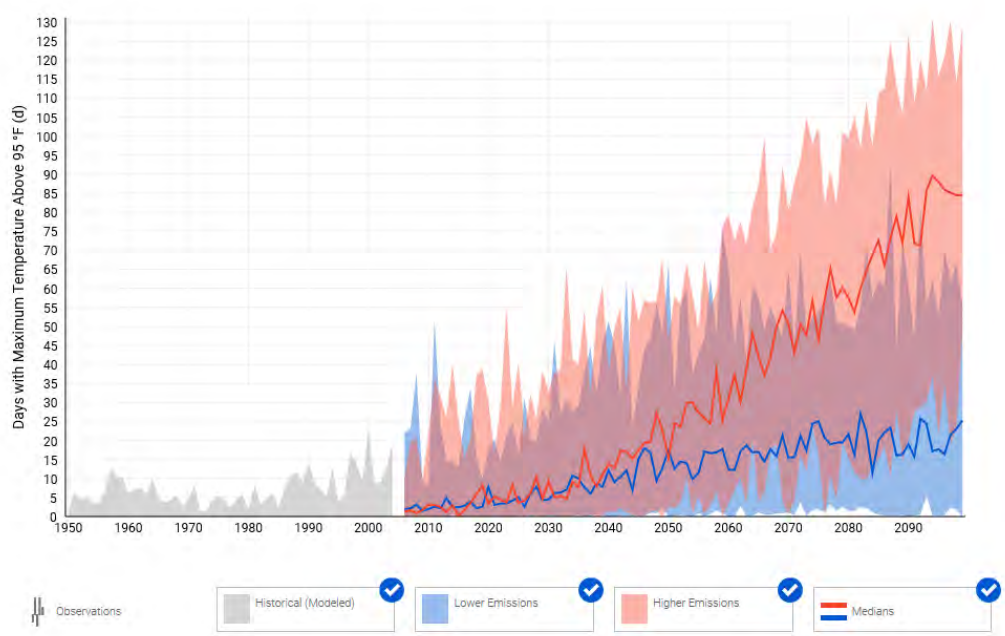
According to the report, average temperatures across the Southeast have increased by an average of 2°F from 1970 to the present, with higher average temperatures during summer months. Temperatures across the Southeast are expected to continue to increase during this century, with shorter-term fluctuations over time due to natural climate variability. Compared to some other areas of the Southeast and the country, the East Tennessee region is expected to experience a relatively milder set of temperature increases. However, projections indicate a clear warming trend for the East Tennessee region, and because warmer air holds more moisture, the Knox County region should expect a generally warmer and wetter climate by the year 2100.

Major consequences to Knox County of this regional warming include significant increases in the number of hot days (95°F or above) and decreases in freezing events. Analysis specific to Knox County suggests a clear increase in the number of days on which maximum temperature exceeds 95°F, with an average of 20-80 more days above 95°F by 2100 when compared to a 1950-2004 reference baseline (see Figure 2.3). Similarly, analysis indicates a decrease in the number of days on which minimum temperatures fall below 32ºF, with an average of approximately 30-55 fewer days reaching below 32ºF by 2100 when compared to a 1950-2004 reference baseline (see Figure 2.4).

The *Climate Change Impacts in the United States* Report also notes that daily and five-day rainfall intensities have increased in the Southeast. Projections of future precipitation patterns are less certain than projections for temperature increases. Because the Southeast is located in the transition zone between projected wetter conditions to the north and drier conditions to the southwest, many of the model projections show only small changes relative to natural variations. However, many models do project drier conditions in the far southwest of the region and wetter conditions in the far northeast of the region, consistent with the larger continental-scale pattern of wetness and dryness.

Modeling from Oak Ridge National Laboratory (ORNL) suggests that in future years, Knox County will experience an average increase in the annual number of very heavy precipitation days (precipitation greater than 0.8 inches) within the subwatersheds (as defined by 12-digit hydrologic unit code, or HUC 12) intersecting Knox County compared to the historical average. Similar analysis by ORNL suggests that future years will experience an average increase in the maximum number of consecutive dry days (precipitation less than 2.5mm) within Knox County subwatersheds compared to the historical average. This move toward more extreme, variable conditions can affect the profile of rain-related hazards in the region, including drought and flooding.

Figure 2.3 Days with Maximum Temperature Above 95°F



Source: National Climate Explorer; https://toolkit.climate.gov/climate-explorer2/location.php?county=Knox+County&city=Knox+County, TN&fips=47093&lat=35.9874629&lon=-83.94197839999998

Figure 2.4 Days with Minimum Temperature Below 32°F

Source: National Climate Explorer; https://toolkit.climate.gov/climate-explorer2/location.php?county=Knox+County&city=Knox+County, TN&fips=47093&lat=35.9874629&lon=-83.94197839999998

2.1.4 Population/Demographics

According to the U.S. Census, the 2010 population for Knox County was 432,226. In 2016, the population is estimated as 456,132, representing a 5.5-percent increase. Populations for the City of Knoxville and the Town of Farragut have also increased during this timeframe at 4.4-percent and 7.6-percent, respectively.

Table 2.2 provides the populations for each city and the unincorporated county for 2000, 2010, and the 2016 Annual Populations Estimates with the percent change from 2010 to 2016.

Table 2.2 Knox County Population 2000-2016 by City

Jurisdiction	2000 Census Population	2010 Census Population	2015 ACS Population Estimate	2016 Annual Population Estimates	% Change 2010-2016
Knox County, TN	423,748	432,266	444,348	456,132	5.5%
City of Knoxville	178,202	178,430	183,066	186,239	4.4%
Town of Farragut	20,154	20,702	21,374	22,282	7.6%

Source: U.S. Census Bureau: 2000 Decennial Census, 2010 Decennial Census, 2016 Population Estimates

According to the 2015 ACS estimates, 5.9 percent of the population is under age 5 and 14.1 percent of the population is over age 65 in Knox County. There were 180,729 households with an average household size of 2.39 people.

The Hazards and Vulnerability Research Institute at the University of South Carolina developed the Social Vulnerability Index (SoVI ®) to evaluate and rank the ability to respond to, cope with, recover from, and adapt to disasters. The index synthesizes 30 socioeconomic variables, which the research literature suggests contribute to reduction in a community's ability to prepare for, respond to, and recover from hazards. SoVI ® data sources include primarily those from the United States Census Bureau.

Figure 2.5 shows that Knox County has a Medium-Low Social Vulnerability Index in comparison with counties within Tennessee. The medium-low index indicates that Knox County is generally able to cope and recover from disasters.

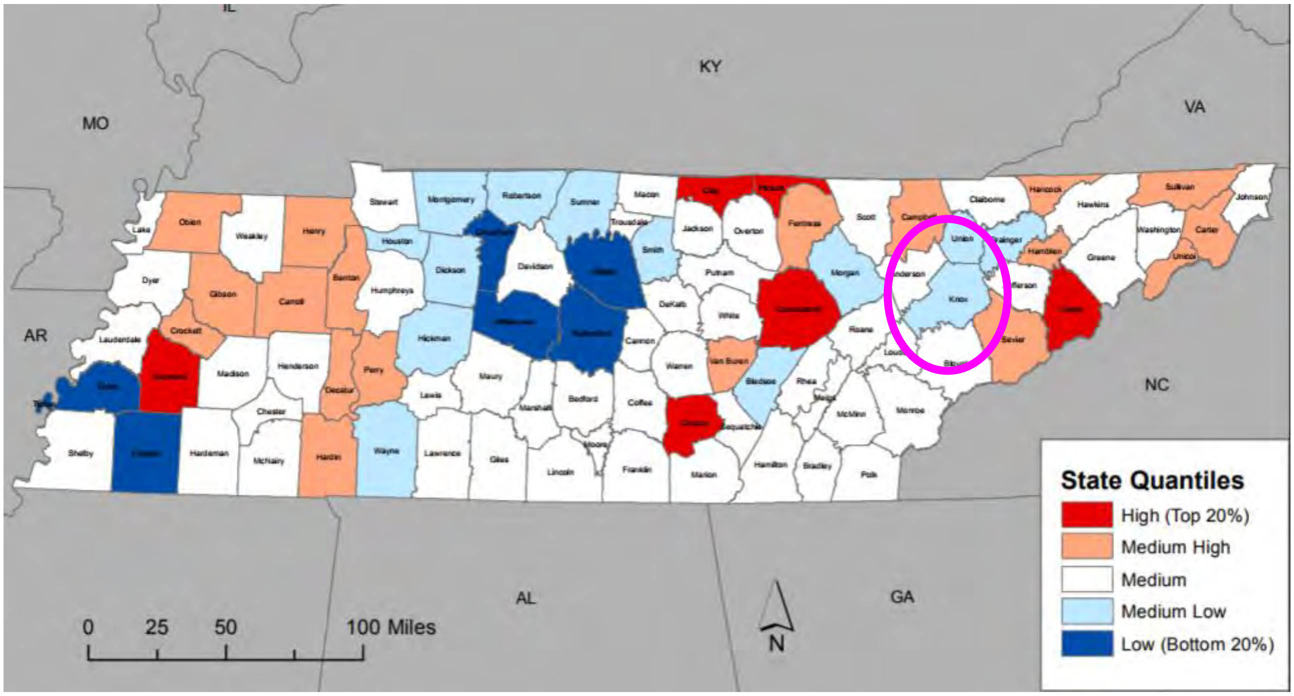
Table 2.3 provides additional demographic and economic indicators for Knox County. The Knox County values are for all of Knox County, including the incorporated cities.

Table 2.3 Unemployment, Income, and Poverty Demographics, Knox County, TN, 2015

Jurisdiction	Civilian Labor Force 16 Years and Over	Unemployment Rate (#)	Unemployment Rate (%)	Median Household Income (2011-2015)	Persons in Poverty (%)
Knox County, TN	240,343	11,370	4.7%	$48,701	15.6%
City of Knoxville	102,266	5,513	5.4%	$34,226	25.7%
Town of Farragut	11,157	437	3.9%	$107,590	4.5%

Source: U.S. Census, 2015 American Community Survey, 5-year Estimates

Figure 2.5 County Comparison Within Tennessee for Social Vulnerability Index, 2010-2014



Source: Hazards and Vulnerability Research Institute,
http://artsandsciences.sc.edu/geog/hvri/sites/sc.edu.geog.hvri/files/attachments/TN_1014.pdf

2.1.5 Economy/Industry

Table 2.4 presents occupational statistics for Knox County, the City of Knoxville, and the Town of Farragut from U.S. Census. Table 2.5 presents the top 25 employers for the Knox County Area.

Table 2.4 Occupational Statistics, Knox County, 2011-2015

Jurisdiction	Civilian Employed Population 16 Years and Over	Management, Business, Science, and Arts Occupations	Service Occupations	Sales and Office Occupations	Natural Resources, Construction, and Maintenance Occupations	Production, Transportation, and Material Moving Occupations
Knox County, TN	215,253	85,455	36,808	56,181	15,713	21,095
City of Knoxville	87,628	30,056	18,139	23,484	6,572	9,289
Town of Farragut	9,527	5,478	1,077	2,201	238	534

Source: U.S. Census, 2015 American Community Survey, 5-year Estimates

Table 2.5 Top 25 Employers in the Knox County Area, 2015-2016

Company	Employees	General Description
U.S. Department of Energy - Oak Ridge Operations	11,986	Government
Covenant Health	10,304	Health Services
Knox County Schools	7,241	Government
The University of Tennessee, Knoxville	6,609	Government
Wal-Mart Stores	5,951	Retail Trade
University Health System	4,941	Health Services
Tennova Heathcare	3,997	Health Services
K-VA-T Food Stores (Food City)	3,913	Retail Trade
Denso Manufacturing-TN	3,800	Manufacturing
State of Tennessee	3,153	Government
Dollywood Co.	3,000	Services
Knox County Government	2,952	Government
Kroger Co.	2,952	Retail Trade
Clayton Homes, Inc.	2,883	Manufacturing
McDonald's Corp.	2,846	Services
Sevier County Schools	2,500	Government
Blount Memorial Hospital	2,418	Health Services
Team Health Holdings	2,015	Health Services
East Tennessee Children's Hospital	2,000	Health Services
Yum! Brands	1,853	Services
Roark Capital Group	1,830	Services
Blount County Schools	1,800	Government
U.S. Postal Service	1,734	Government
McGhee Tyson Air National Guard Base	1,717	Military
CVS Health	1,673	Retail Trade

Source: Knoxville-Oak Ridge Innovation Valley; http://www.knoxvilleoakridge.com/data/

2.1.6 Agriculture

Agriculture is a declining component of the economy in Knox County. Table 2.6 below compares number of farms and land in farms (acres) as reported in the 2002, 2007, and 2012 US Agricultural census.

Table 2.6 Knox County Agricultural Census Comparisons, 2002, 2007, and 2012

Commodity	2002	2007	2012	Percent Change 2007-2012
Farms (number)	1,410	1,224	912	-25%
Land in farms (acres)	93,563	82,938	65,347	-21%
Market Value – Crops ($1,000)	$13,658	$11,971	$8,672	-25%
Market Value – Livestock ($1,000)	$6,579	$7,408	$5,951	

Source: USDA Census of Agriculture, 2002, 2007, and 2012; https://www.agcensus.usda.gov/

Table 2.7 below shows the production quantity and the state rank, among the 95 counties, for agricultural products in Knox County.

Table 2.7 Knox County Agricultural Commodity Groups, 2012

Commodity	Quantity ($)	State Rank
Grains, oilseeds, dry beans, & dry peas	228,000	85
Vegetables, melons, potatoes, & sweet potatoes	163,000	34
Fruits, tree nuts, & berries	118,000	16
Nursery, greenhouse, floriculture, & sod	7,576,000	8
Other crops and hay	494,000	40
Poultry and eggs	19,000	68
Cattle and calves	5,118,000	54
Hogs and pigs	8,000	67
Sheep, goats, and their products	82,000	39
Horses, ponies, mules, burros, and donkeys	211,000	36

Source: U.S. Department of Agriculture, 2012 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
Benefits
Codes
Communications
Community
Development
Constituent Services
Construction Services
Elections Committee
Finance
Fire Prevention Bureau
Health Department
Human Resources
Information Technology
Internal Audit
KGIS
Parks & Recreation Public
Library
Procurement
Records Management
Regional Forensic Center
Retirement
Senior Services
Stormwater Management
Trash & Recycling Services
Veteran’s Services

Technical and Fiscal Resources

Knoxville-Knox County has a joint city-county office for emergency management services. The table below outlines Knox County personnel resources in 2017.

Table 2.8 Knox County Administrative and Technical Resources, 2017

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	YES	• Knox County Community Development Department (KCCD) • Engineering & Public Works - Planning & Development Division • Knoxville-Knox County Metropolitan Planning Commission
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	YES	• Engineering & Public Works - Planning & Development Division • Code Administration • Highway and Bridge Division
Planner/Engineer/Scientist with an understanding of natural hazards	YES	• Engineering & Public Works • Knoxville-Knox County Metropolitan Planning Commission
Personnel skilled in GIS	YES	• KGIS • Knoxville-Knox County Metropolitan Planning Commission • Engineering & Public Works
Full time building official	YES	• Code Administration
Floodplain Manager	YES	• Engineering & Public Works – Stormwater Management
Emergency Manager	YES	• KEMA
Grant writer	YES	• Various Departments, not sole office

Source: Knox County's Data Collection Workbook completed 2017.

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

- Community Development Block Grants;
- DHS and FEMA Grant Resources;
- Capital improvements project funding;
- Authority to levy taxes for specific purposes;
- Incur debt through general obligation bonds;
- Incur debt through special tax bonds; and
- Incur debt through private activities.

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. Additional regulatory tools are presented in the table below:

Table 2.9 Knox County Regulatory Tools, 2017

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
General Plan	YES	Knoxville-Knox County General Plan 2033 http://knoxmpc.org/generalplan/
Zoning ordinance	YES	http://www.knoxmpc.org/zoning/zonhome.htm
Subdivision ordinance	YES	Knoxville-Knox County Minimum Subdivision Regulations http://archive.knoxmpc.org/zoning/subreg.pdf
Growth management	YES	Growth Policy Plan, 2001 http://archive.knoxmpc.org/plans/growthpl.htm
Floodplain ordinance	YES	No. O-94-3-101 https://www.knoxcounty.org/stormwater/manual/Volume%201/Appendices/A/knoxco_swmm_v1_app_a2.pdf
Other special purpose ordinance (stormwater, steep slope, wildfire)	YES	Stormwater Ordinance - https://knoxcounty.org/stormwater/volume2.php Hillside and Ridgetop Protection Plan – http://archive.knoxmpc.org/plans/taskforce/hrpp_adopted.pdf
Building code	YES	Adoption of 2012 International Code Councils https://www.knoxcounty.org/codes/pdfs/code_adoption_admend.pdf
BCEGS Rating	YES	3-Commercial and 4-Residentail
Fire department ISO rating	YES	Ratings:4-6 (varies across county)
Erosion or sediment control program	YES	See Stormwater Ordinance
Stormwater management program	YES	https://www.knoxcounty.org/stormwater/
Site plan review requirements	YES	Code Administration https://www.knoxcounty.org/codes/permitinfo.php Stormwater Management https://www.knoxcounty.org/stormwater/dev.php https://www.knoxcounty.org/stormwater/permits.php
Capital improvements plan	YES	Knox County Engineering & Public Works Capital Projects Division https://www.knoxcounty.org/epw/capitalprojectsdivision.php
Economic development plan	YES	Development Corporation of Knox County, Tennessee (TDC) and Knoxville-Knox County General Plan 2033

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
		http://knoxmpc.org/generalplan/
Local emergency operations plan	YES	KEMA http://www.knoxvilletn.gov/government/city_departments_offices/knoxville-knox_co_emergency_management_agency/
Flood insurance study or other engineering study for streams	YES	Stormwater Management https://www.knoxcounty.org/stormwater/floodplain.php FIS 47093CV001B-4B; August 5, 2013
Elevation certificates	YES	Stormwater Management https://www.knoxcounty.org/stormwater/permits.php

Other Mitigation Activities

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

Knoxville-Knox County Emergency Management Agency (KEMA)

The joint City-County Emergency Management Agency provides the following services:

- **Emergency Planning -** KEMA researches, revises, prints and distributes the Knoxville-Knox County Basic Emergency Plan.
- **Training to Emergency Responders and Public Organizations -** KEMA will host/present training classes and/or presentations to response agencies, doctors, nurses and public organizations on topics such as Terrorism, Weapons of Mass Destruction, Assisting Children in Disasters, Structural Collapse, Incident Command, Weather Spotter and CERT.
- **Citizen Preparedness Information -** KEMA is the administrator for the Knoxville Local Emergency Planning Committee and hosts the website http://knoxtnlepc.org. The site includes pages for MMRS, CERT, DART and a Get Ready Knoxville Preparedness program page. The program provides Free READY KIT bags to encourage citizens to put together an emergency kit.
- **Participate in Emergency Exercises -** KEMA participate in numerous emergency exercises every year.
- **Provide and Maintain EOC Facilities -** The 9-1-1/KEMA facility houses the EOC - Emergency Operations Center. This is the central meeting point for the City and County Mayors, Police, Fire, Emergency Medical Services, American Red Cross and others to coordinate response and recovery efforts following a disaster.
- **Grant Administration -** KEMA administers several State and Federal Grants which provide emergency planning, training and equipment to emergency responders, hospitals and volunteers.
- **Duty Officer -** A duty officer is on call 24 hours a day, 7 days a week.

Fire Prevention Bureau

The Knox County Fire Prevention Bureau protects the residents of Knox County through life safety inspections of existing structures and new construction, development of proactive and diverse public education programs, and maintaining an aggressive fire investigation 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.
- Knox county Air Quality Management Department also has programs such as, Air Now, Spare the Air, SunWise, and other public outreach programs.

Health Department

- Emergency Preparedness Department Works to establish and ensure Public Health preparedness and effective response capability to infectious disease outbreaks, bioterrorism, public health threats and other emergencies.

2.2.2 City of Knoxville

The City of Knoxville 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. The City of Knoxville mitigation capabilities are provided below as reported in their completed data collection workbooks and Table 2.16 at the end of this section summarizes the mitigation related capabilities of the City of Knoxville.

Overview

The City of Knoxville is governed by a Mayor and a nine-member City Council. There are 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 32 offices and departments:

- 3-1-1
- Business Support
- City Court
- Civic Facilities
- Civil Service
- Communications
- Community Development
- Community Relations
- Employee Benefits
- Engineering
- Finance
- Fire Department
- Fleet Services
- Information Systems
- Knoxville Area Transit (KAT)
- Knoxville Convention Center
- KEMA
- Law
- Neighborhoods
- Operations
- Parks and Recreation
- Plans Review & Inspections
- Police Department
- Policy Advisory & Review Committee
- Policy
- Public Service
- Purchasing
- Real Estate
- Redevelopment
- Risk Management
- Special Events
- Sustainability

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. Table 2.10 outlines the City's personnel resources in 2017.

Table 2.10 City of Knoxville Administrative and Technical Resources, 2017

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	YES	• Engineering • Redevelopment • Knoxville-Knox County Metropolitan Planning Commission
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	YES	• Engineering • Plans Review & Inspections - Code Administration
Planner/Engineer/Scientist with an understanding of natural hazards	YES	• Engineering • Knoxville-Knox County Metropolitan Planning Commission
Personnel skilled in GIS	YES	• KGIS • Knoxville-Knox County Metropolitan Planning Commission • Engineering
Full time building official	YES	• Plans Review & Inspections - Code Administration
Floodplain Manager	YES	• Engineering – Stormwater Engineering Division
Emergency Manager	YES	• KEMA
Grant writer	YES	• Various Departments, not sole office

Source: Knoxville's Data Collection Workbook completed 2017.

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

- Community Development Block Grants;
- DHS and FEMA Grant Resources;
- Capital improvements project funding;
- Authority to levy taxes for specific purposes;
- Incur debt through general obligation bonds;
- Incur debt through special tax bonds; and
- Incur debt through private activities.

Existing Plans and Policies

The City of Knoxville joined the regular phase of the National Flood Insurance Program on April 30, 1971 and also participates in the Community Rating System as a Class 8 community. They maintain elevation certificates on properties in the floodplain. Additional regulatory tools are presented in the table below:

Table 2.11 City of Knoxville Regulatory Tools, 2017

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
General Plan	YES	Knoxville-Knox County General Plan 2033 http://knoxmpc.org/generalplan/
Zoning ordinance	YES	http://www.knoxmpc.org/zoning/zonhome.htm

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Subdivision ordinance	YES	Knoxville-Knox County Minimum Subdivision Regulations http://archive.knoxmpc.org/zoning/subreg.pdf
Growth management	YES	Growth Policy Plan, 2001 http://archive.knoxmpc.org/plans/growthpl.htm
Floodplain ordinance	YES	Chapter 12 of the City Code - Flood Damage Prevention and Control Ordinance http://www.knoxvilletn.gov/government/city_departments_offices/engineering/stormwater_engineering_division/floodplains
Other special purpose ordinance (stormwater, steep slope, wildfire)	YES	Stormwater and Street Ordinance - http://www.knoxvilletn.gov/UserFiles/Servers/Server_109478/File/Engineering/LDManual/LD-AppB.pdf Hillside and Ridgetop Protection Plan – http://archive.knoxmpc.org/plans/taskforce/hrpp_adopted.pdf
Building code	YES	Adoption of 2012 International Code Councils http://www.knoxvilletn.gov/cms/One.aspx?portalId=109562&pageId=190576
BCEGS Rating	YES	3-Commercial and 4-Residentail
Fire department ISO rating	YES	3
Erosion or sediment control program	YES	Knoxville BMP Manual http://www.knoxvilletn.gov/UserFiles/Servers/Server_109478/File/Engineering/BMPManual/KnoxvilleBMP.pdf
Stormwater management program	YES	http://www.knoxvilletn.gov/government/city_departments_offices/engineering/stormwater_engineering_division/
Site plan review requirements	YES	Plans Review & Inspections http://www.knoxvilletn.gov/cms/One.aspx?portalId=109562&pageId=190567 Stormwater Engineering – Land Development Manual http://www.knoxvilletn.gov/cms/one.aspx?portalId=109562&pageId=195442
Capital improvements plan	YES	City Capital Improvement Program http://www.knoxvilletn.gov/UserFiles/Servers/Server_109478/File/Finance/Budget/2017/cip.pdf Engineering – Capital Improvements Projects http://www.knoxvilletn.gov/government/city_departments_offices/engineering/capital_improvements_projects
Economic development plan	YES	Knoxville-Knox County General Plan 2033 http://knoxmpc.org/generalplan/ Knoxville Chamber of Commerce http://www.knoxvillechamber.com/economic-development
Local emergency operations plan	YES	KEMA http://www.knoxvilletn.gov/government/city_departments_offices/knoxville-knox_co_emergency_management_agency/

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Flood insurance study or other engineering study for streams	YES	Stormwater Engineering http://www.knoxvilletn.gov/cms/One.aspx?portalId=109562&pageId=195458 FIS 47093CV001B-4B; August 5, 2013
Elevation certificates	YES	Stormwater Engineering http://www.knoxvilletn.gov/cms/One.aspx?portalId=109562&pageId=195458

Other Mitigation Activities

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

Knoxville-Knox County Emergency Management Agency (KEMA)
The joint City-County Emergency Management Agency provides multiple services, see Knox County.

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 provided 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.

Sustainability
The Energy & Sustainability Initiative began in 2007 to make Knoxville a greener, more sustainable city – one where the environment, economy, and community can thrive today and in the long term. The responsibility includes addressing climate change through mitigation and adaptation activities. The Energy & Sustainability Initiative seeks to reduce the greenhouse gas emissions associated with City operations and the Knoxville community each by 20% by 2020 relative to 2005 levels. Activities fall within seven broad categories:

- Community Engagement;
- Energy;
- Goods & Services;
- Sustainable Landscapes;

- Infrastructure;
- Transportation; and
- Sustainable Growth

2.2.3 Town of Farragut

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. The Town of Farragut mitigation capabilities are provided below as reported in their completed data collection workbooks and Table 2.16 at the end of this section summarizes the mitigation related capabilities of the Town of Farragut.

Overview

The Town of Farragut 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
Building & Fire Codes
Engineering
Parks & Leisure Services
Planning & Land Use
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 2.12 outlines the City's personnel resources in 2017.

Table 2.12 Farragut's Administrative and Technical Resources, 2017

Personnel Resources	Yes/No	Department/Position
Planner/Engineer with knowledge of land development/land management practices	YES	• Community Development Department
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	YES	• Code Enforcement Division
Planner/Engineer/Scientist with an understanding of natural hazards	YES	• Engineering • Community Development
Personnel skilled in GIS	YES	• KGIS • Engineering • Community Development
Full time building official	YES	• Code Enforcement Division
Floodplain Manager	YES	• Engineering – Stormwater Matters Program
Emergency Manager	YES	• Knox County Sheriff's Office • Rural Metro Fire Department • Knoxville Volunteer Rescue Squad
Grant writer	YES	• Various Departments, not sole office

Source: Farragut Data Collection Workbook completed 2017.

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

- DHS and FEMA Grant Resources;
- Capital improvements project funding;
- Authority to levy taxes for specific purposes;
- Incur debt through general obligation bonds; and
- Incur debt through special tax bonds.

Existing Plans and Policies

The Town of Farragut joined the regular phase of the National Flood Insurance Program on July 23, 1971. They maintain elevation certificates on properties in the floodplain. Table 2.13 below details regulatory tools for the Town of Farragut.

Table 2.13 Town of Farragut Regulatory Tools, 2017

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
General Plan	YES	Comprehensive Land Use Plan: Farragut 2025 http://www.townoffarragut.org/DocumentCenter/View/1150
Zoning ordinance	YES	Part II Code of Ordinances Appendix A – Zoning https://library.municode.com/tn/farragut/codes/code_of_ordinances?nodeId=PTIICOOR_APXAZO
Subdivision ordinance	YES	Part II Code of Ordinances Appendix B – Subdivisions https://library.municode.com/tn/farragut/codes/code_of_ordinances?nodeId=PTIICOOR_APXBSU
Growth management	YES	Urban Growth Boundary http://www.townoffarragut.org/DocumentCenter/View/310
Floodplain ordinance	YES	Part II Code of Ordinances Appendix A – Zoning Chapter 4; Section VIII https://library.municode.com/tn/farragut/codes/code_of_ordinances?nodeId=PTIICOOR_APXAZO_CH4GEPREX_SVIIIFAMUFLDAPRRE
Other special purpose ordinance (stormwater, steep slope, wildfire)	YES	Stormwater Management and Low-Impact Development https://library.municode.com/tn/farragut/codes/code_of_ordinances?nodeId=PTIICOOR_APXDARDEST_1.0SIDEGU_STMALPADE Sinkholes - https://library.municode.com/tn/farragut/codes/code_of_ordinances?nodeId=PTIICOOR_CH107MIPR_ART3SI_S107-61DE

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
Building code	YES	Adoption of 2012 International Code Councils http://www.townoffarragut.org/DocumentCenter/View/512
BCEGS Rating	YES	3
Fire department ISO rating	YES	4
Erosion or sediment control program	YES	http://www.townoffarragut.org/286/Construction-Stormwater-Management
Stormwater management program	YES	Stormwater Matters Program http://www.townoffarragut.org/171/Stormwater-Matters-Program
Site plan review requirements	YES	Building & Fire Codes http://www.townoffarragut.org/130/Building-Fire-Codes Stormwater Matters Program – Grading Permit http://www.townoffarragut.org/faq.aspx?qid=63
Capital improvements plan	YES	Capital Investment Plan, 2015-2019 http://www.townoffarragut.org/documentcenter/view/638
Economic development plan	YES	Farragut/West Knox Chamber of Commerce Farragut Business Alliance http://www.townoffarragut.org/438/Economic-Development
Local emergency operations plan	YES	KEMA http://www.knoxvilletn.gov/government/city_departments_offices/knoxville-knox_co_emergency_management_agency/
Flood insurance study or other engineering study for streams	YES	FIS 47093CV001B-4B; August 5, 2013
Elevation certificates	YES	Building & Fire Codes – Bldg Permit Application http://www.townoffarragut.org/DocumentCenter/View/1774

Source: Farragut Data Collection Workbook completed 2017.

Other Mitigation Activities

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

- Stormwater Matters Program – 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

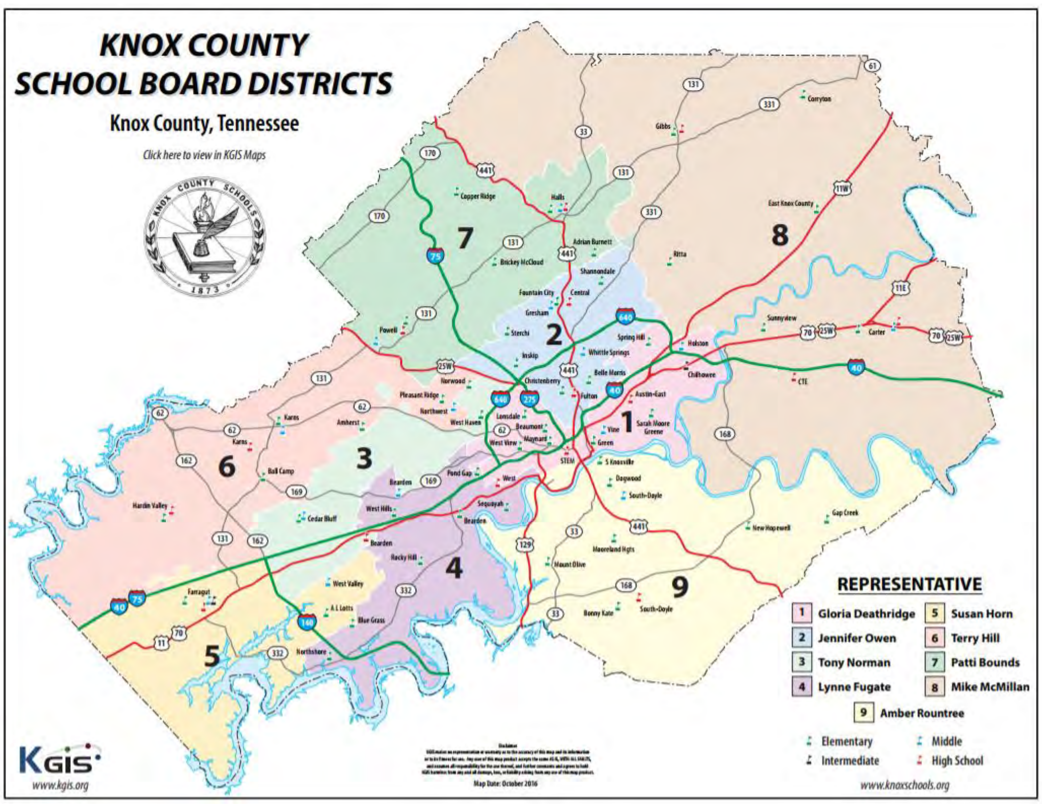
years and the data collected will be useful in stream restoration efforts in East Tennessee.

- 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.

2.2.4 Knox County Schools

The Knox County Schools operate within policies set by a nine-member Board of Education. Board Members are elected by district to a four-year term. Their constituency includes residents from the City of Knoxville, Knox County and the Town of Farragut. This body provides direction and oversight for all public schools within the county. The Superintendent is appointed by the Board of Education and serves as the chief executive officer of the school system. Figure 2.6 provides the boundaries of the school board districts in Knox County and Table 2.14 that follows provides location and enrollment information for each school district.

Figure 2.6 Knox County School Board Districts and School Locations



Source: KGIS

Table 2.14 Knox County School Buildings, Enrollment, and Staffing Data, 2017

Knox County Schools Counts	Number
Schools	
Elementary Schools	50
Middle Schools	14
High Schools	16
Special Schools	9
Total Number of Schools	**89**
Student Enrollment	
Pre-K	1,466
Elementary School (K-5)	27,517
Middle School (6-8)	13,103
High School (9-12)	17,190
Total Number of Students	**59,516**
Classroom Teachers/Principals	
Classroom Teachers	3,927
Principals	85
Assistant Principals	126
Other Certified	549
Support Staff	3,652
Total Number of Employees	**8,339**

Source: Knox County Schools; https://www.knoxschools.org/Page/5504

Table 2.15 provides a summary of the reported capabilities for the Knox County Schools.

Table 2.15 Summary of Mitigation Capabilities, Knox County Schools

Capability	Knox County Schools
Planning Elements	
Master Plan	School Year 2017-18 Pending; Updated Every School Year
Capital Improvement Plan	Revised each School Year
School Emergency Plan	Yes; Shelter-in-Place and Evacuation Protocols; updated every school year (by school)
Weapons Policy	Yes; TCA § 39-17-1309
Personnel Resources	
Full-time building official (i.e. principal)	Yes; Superintendent over all schools
Emergency Manager	No; Chief of Security; Security takes the lead on EM; Coordinates, as necessary, with KEMA

Capability	Knox County Schools
Grant Writer	Yes
Public Information Officer	Yes; Public Affairs/Director
Financial Resources	
Capital Improvements project funding	Yes
Local funds	Yes
General obligation bonds	No
Special tax bonds	No
Private activities/donations	No
State and federal funds	No
Other	
Public Address/Emergency Alert System	All buildings are equipped with a public-address system. Schools are also issued bullhorns for public address outside of the facility or emergency use.
NOAA Weather Radios	Yes; All schools are equipped with NOAA Weather Radios, monitored at the front desk/school secretary (In most facilities) and checked for malfunctions regularly by the officer assigned to each school. Each school is also issued an emergency two-way radio which connect directly to School Security Dispatch.
Mitigation Programs to reduce losses / Public Education Programs	Mandated fire drills, severe weather drills, AED/cardiac emergency drills, lockdown (3 levels) drills, earthquake drills, reverse evacuations, rapid evacuations, shelter-in-place drills, and school bus evacuation drills. Table top exercises are also conducted with other public safety agencies at school.
Tornado Shelter/Saferoom	No, In most buildings the hallways are utilized for severe weather protection.
Remodel/Reconstruction Projects	Yes, two schools currently under construction (Hardin Valley Middle and Gibbs Middle). Current renovation at Pond Gap Elementary.
Campus Police	School Resource Officer through partnership with Adel Police Dept.

Source: Knox County Schools Data Collection Workbook completed 2017.

2.2.5 Summary of Mitigation Capabilities

The following is a summary of the mitigation capabilities of the three participating jurisdictions and Knox County Schools.

Table 2.16 Knox County Jurisdictions: Summary of Mitigation Capabilities

Capability	Knox County	City of Knoxville	Town of Farragut	Knox County Schools
General Plan	Yes	Yes	Yes	Yes
Emergency Operations Plan	Yes	Yes	Yes	Yes
Economic Development Plan/Policy	Yes	Yes	Yes	---
Capital Improvements Plan	Yes	Yes	Yes	Yes
Building Code	Yes	Yes	Yes	---
Building Code Year	2012 IBC	2012 IBC	2012 IBC	---
Building Code Effectiveness Grading Schedule Rating	3-commercial 4-residential	N/A	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	---

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 the planning area, including loss of life, personal injury, property damage, and economic loss, from a hazard event. The risk assessment process allows communities in the planning area 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.

A Multi-Jurisdictional Local Hazard Mitigation Plan was adopted in 2011. This risk assessment is an update to the risk assessment previously prepared. Updates to the risk assessment include the following:

- Identified hazards were re-evaluated and profiles were refined;
- Hazus 4.0, Tennessee State Dataset was utilized to determine loss estimates;
- Hazus 4.0, results assessed vulnerability and loss estimates for earthquake and flooding; and
- Critical facilities were updated with KGIS 2017 Points of Interest dataset.

The risk assessment followed the methodology described in the 2013 FEMA Local Mitigation Planning Handbook, which includes a four-step process:

- Step 1 - Describe Hazards
- Step 2 - Identify Community Assets
- Step 3 - Analyze Risk
- Step 4 - Summarize Vulnerability

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 planning area’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 2 and 3 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 2013 update to the State of Tennessee Hazard Mitigation Plan. The eight natural hazards of prime concern that were included in the State Plan are listed alphabetically below:

- Dam Failure;
- Drought;
- Earthquake;
- Extreme Temperatures (includes Extreme Heat and Extreme Cold);
- Flood;
- Geologic Hazards, includes:
  - Expansive Soils;
  - Land Subsidence/Sinkholes; and
  - Landslides;
- Severe Storms, includes
  - Thunderstorms (Hail, High Winds, Lightning); and
  - Winter Storms;
- Tornadoes; and
- Wildfires.

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 2013)
- Information on past hazard events from the Spatial Hazard Events and Losses Database for the United States (SHELDUS), a component of the University of South Carolina Hazards & Vulnerability and Research Institute
- Information on past extreme weather and climate events and projected trends from the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center and Climate Explorer.
- 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.

Table 3.1 lists federal disaster declarations received by Knox County. Each of the disaster events affected multiple counties; estimated damages reflect total losses to all counties. Severe storms, tornadoes, and flooding were the most prevalent disasters.

It is also important to note that the federal government may issue a disaster declaration through the U.S. Department of Agriculture and/or the Small Business Administration, as well as through FEMA. The quantity and types of damage are the factors that determine whether such declarations are issued.

The U.S. Department of Agriculture (USDA) provides assistance to farmers and other rural residents, as the result of natural disasters. Agricultural-related disasters are quite common. One-half to two-thirds of the counties in the United States have been designated as disaster areas in each of the past several years. Agricultural producers may apply for low-interest emergency loans in counties named as primary or contiguous in a disaster designation.

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

DR #	Declaration Date	Disaster Description	Counties Included for Public Assistance	Counties Included for Individual Assistance	Public Assistance ($)	Individual Assistance ($)
Major Disaster Declarations						
4211	4/2/2015 (2/15-23/2015)	Severe Winter Storm and Flooding	Anderson, Bedford, Bledsoe, Blount, Campbell, Claiborne, Clay, Cocke, Coffee, Cumberland, Davidson, DeKalb, Fentress, Giles, Grainger, Greene, Grundy, Hamblen, Hancock, Hardeman, Hardin, Hawkins, Jefferson, **Knox**, Lawrence, Loudon, Marshall, McMinn, McNairy, Meigs, Monroe, Moore, Morgan, Obion, Overton, Pickett, Putnam, Rhea, Roane, Scott, Sevier, Van Buren, Warren, Wayne and White.	None	$28,739,512	None
4005	7/20/2011 (6/18-24/2011)	Severe Storms, Straight-line Winds, Tornadoes, and Flooding	Anderson, Claiborne, Grainger, Henderson, **Knox**, Loudon and Marion.	None	$6,749,077	None
1974	5/1/2011 (4/25-28/2011)	Severe Storms, Straight-line Winds, Tornadoes, and Flooding	Benton, Bledsoe, Blount, Bradley, Campbell, Carroll, Chester, Cocke, Crockett, Fayette, Fentress, Franklin, Gibson, Giles, Greene, Hamilton, Hardeman, Hardin, Henderson, Henry, Hickman, Houston, Humphreys, Jackson, Jefferson, Johnson, **Knox**, Lake, Lawrence, Lewis, Lincoln, Loudon, Madison, Marion, Marshall, McMinn, McNairy, Monroe, Montgomery, Moore, Perry, Pickett, Polk, Rhea, Scott, Sequatchie, Shelby, Smith, Sullivan, Washington, Wayne and Weakley.	Bledsoe, Bradley, Carroll, Cocke, Crockett, Greene, Hamilton, Hardin, Henry, Johnson, **Knox**, Madison, McMinn, Monroe, Montgomery, Rhea and Washington.	$52,394,427	$8,596,963

DR #	Declaration Date	Disaster Description	Counties Included for Public Assistance	Counties Included for Individual Assistance	Public Assistance ($)	Individual Assistance ($)
1464	5/8/2003 (5/4/2003)	Severe Storms, Tornadoes, and Flooding	Bedford, Benton, Bradley, Campbell, Cannon, Carroll, Cocke, Cumberland, DeKalb, Dickson, Dyer, Gibson, Giles, Grundy, Hamilton, Hardeman, Hardin, Haywood, Henderson, Henry, Hickman, Houston, Humphreys, Jackson, Lake, Lauderdale, Lawrence, Lewis, Lincoln, Macon, Madison, Marion, Marshall, Maury, McMinn, Meigs, Monroe, Montgomery, Morgan, Obion, Perry, Polk, Rhea, Roane, Rutherford, Sequatchie, Smith, Stewart, Sumner, Tipton, Trousdale, Warren, Wayne, Weakley, White and Williamson.	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.	Not Available	Not Available
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.	None	Not Available	None

DR #	Declaration Date	Disaster Description	Counties Included for Public Assistance	Counties Included for Individual Assistance	Public Assistance ($)	Individual Assistance ($)
1215	4/20/1998 (4/16-5/18/1998)	Severe Storms, Tornadoes, and Flooding	Anderson, Campbell, Claiborne, Davidson, Dickson, Grainger, Hancock, Hawkins, Humphreys, Jackson, Jefferson, **Knox**, Lauderdale, Lawrence, Loudon, Maury, Morgan, Pickett, Polk, Roane, Scott, Union, Wayne and Wilson.	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.	Not Available	Not Available
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	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	Not Available	Not Available

DR #	Declaration Date	Disaster Description	Counties Included for Public Assistance	Counties Included for Individual Assistance	Public Assistance ($)	Individual Assistance ($)
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	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	Not Available	Not Available
Emergency Declarations						
EM-3217	September 5, 2005 (8/29-10/1/2005)	Hurricane Katrina Evacuation	Statewide-All Counties	None	N/A	None
EM-3095	March 14, 1993 (3/13-3/17/93)	Severe Snowfall, Winter Storm	Anderson, Bedford, Bledsoe, Blount, Bradley, Campbell, Cannon, Carter, Claiborne, Clay, Cocke, Coffee, Cumberland, DeKalb, Fentress, Franklin, Grainger, Greene County, 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, Wilson	None	Not Available	None

Source: FEMA Disaster Declarations, https://www.fema.gov/disasters/grid/state-tribal-government/53?field_disaster_type_term_tid_1=All

USDA Secretarial disaster designations must be requested of the Secretary of Agriculture by a governor or the governor's authorized representative, or by an Indian Tribal Council leader. Primary and contiguous counties designations for 2012 through 2017 were as follows:

- 2017 - Primary County - Knox
- 2016 - Primary County – Knox (two drought events)
- 2014 - Contiguous County - Knox
- 2012 - Contiguous County – Knox

The Small Business Administration provides disaster assistance to families and businesses through their Disaster Assistance Program. The mission of this program is to offer financial assistance to those who are trying to rebuild their homes and businesses in the aftermath of a disaster. By offering low-interest loans, the SBA is committed to long-term recovery efforts. SBA is also committed to mitigation, and has additional loan programs to help reduce future losses.

An SBA declaration may be requested by State Governor. When the Governor's request for assistance is received, a survey of the damaged area(s) is conducted with State and local officials, and the results are submitted to the Administrator for a decision. When the Administrator of SBA declares an area, both primary and adjacent counties are eligible for the same assistance. Knox County was included in the following SBA declarations:

- TN-00103 – 2017, Severe Thunderstorms with Damaging Winds
- TN-00099 – 2016, Wildfires
- TN-00048 – 2011, Knox County
- TN-00051 – 2011, Knox County

3.1.3 Hazards Identified

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 3.2 with an "X" indicating the affected jurisdictions. Each of these hazards is profiled in further detail in the next section.

Table 3.2 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 / 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

* Dam failure was continued to be profiled as a separate hazard from flood since dams can fail during non-flood conditions.

The HMPC continued to choose not to include manmade and technological hazards in the Mitigation Plan Update for two reasons: (1) evaluation of these hazards is not necessary for plans to meet the requirements of the Disaster Mitigation Act of 2000; and (2) these hazards are profiled and planned for in other plans such as the Local Emergency Operations Plan and Knox County Public Health Plans.

3.1.4 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 the planning area.

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.

3 - Extensive: 50-100% of planning area
2 - Significant: 10-50% of planning area
1 - Limited: Less than 10% of planning area

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.

- ***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.

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.

- ***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

Changing Future Conditions

This section presents potential changes to each hazard that are expected to occur due to variations in environment and climate. Predictions about the changes are contingent upon available research; therefore, some hazards have limited or unknown information. It is difficult to predict the scope, severity, and pace of changing future conditions and the impacts posed by more intense storms, frequent heavy participation, heat waves, drought, and extreme flooding; none-the-less, according to the FEMA Climate Change Adaptation Policy Statement, they can significantly change the probabilities and magnitudes of hazards faced by communities.

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.

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 3.3 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 3.3 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	2	1	3	1.85	Low
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 on 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 the entire structures.

Geographic Location

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

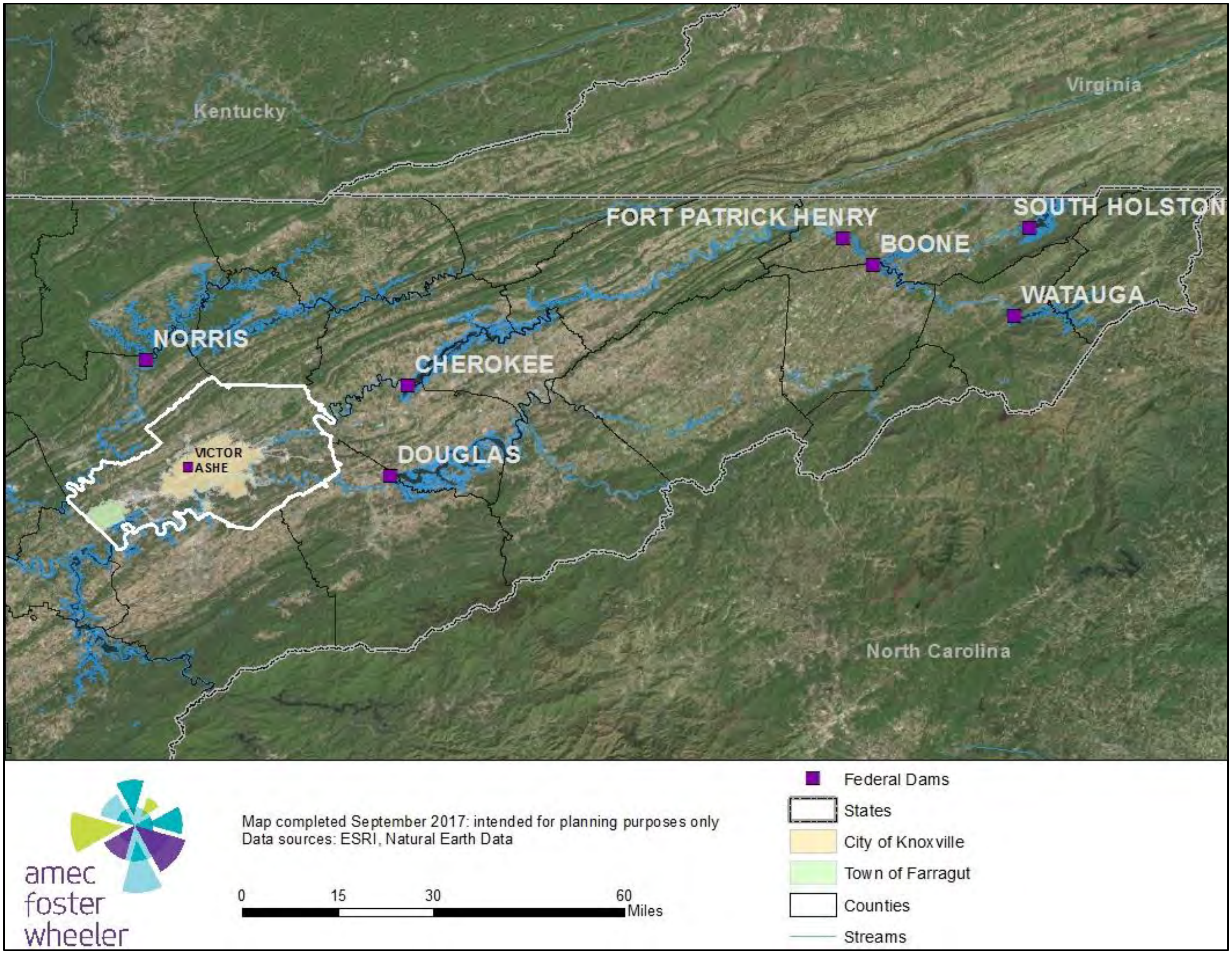
The upstream federal dams regulated by the TVA that could impact the planning area in the event of failure are listed in Table 3.4 and displayed in Figure 3.0 – 3.8.

Table 3.4 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

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

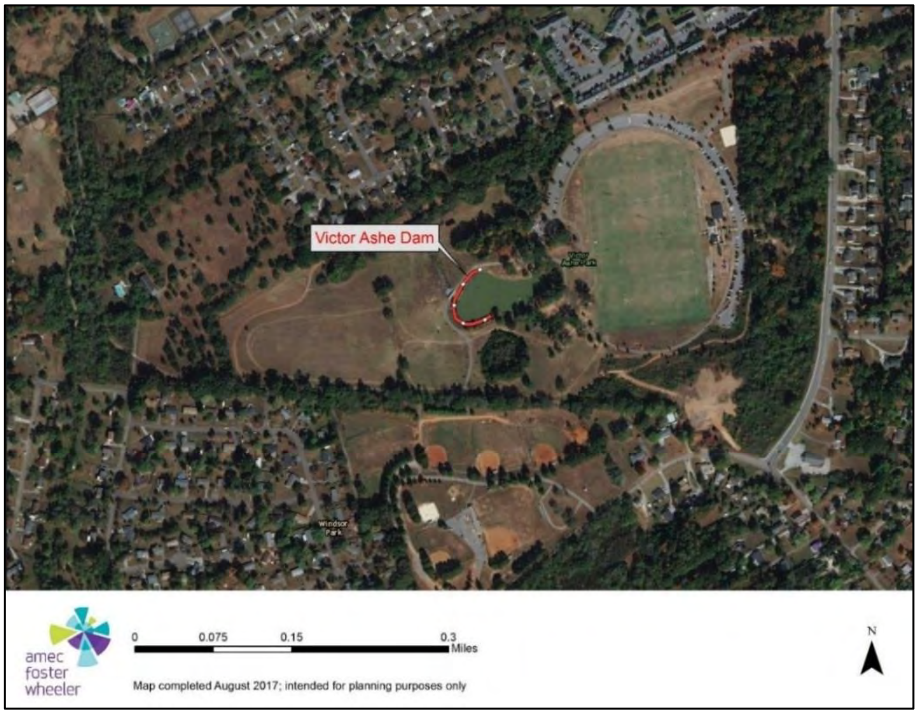
Figure 3.0 Upstream Federal Dams



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 the figure below.

Figure 3.1. Victor Ashe Dam



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 3.2. 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 3.3. 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 3.4. 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 3.5. 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 3.6. 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.

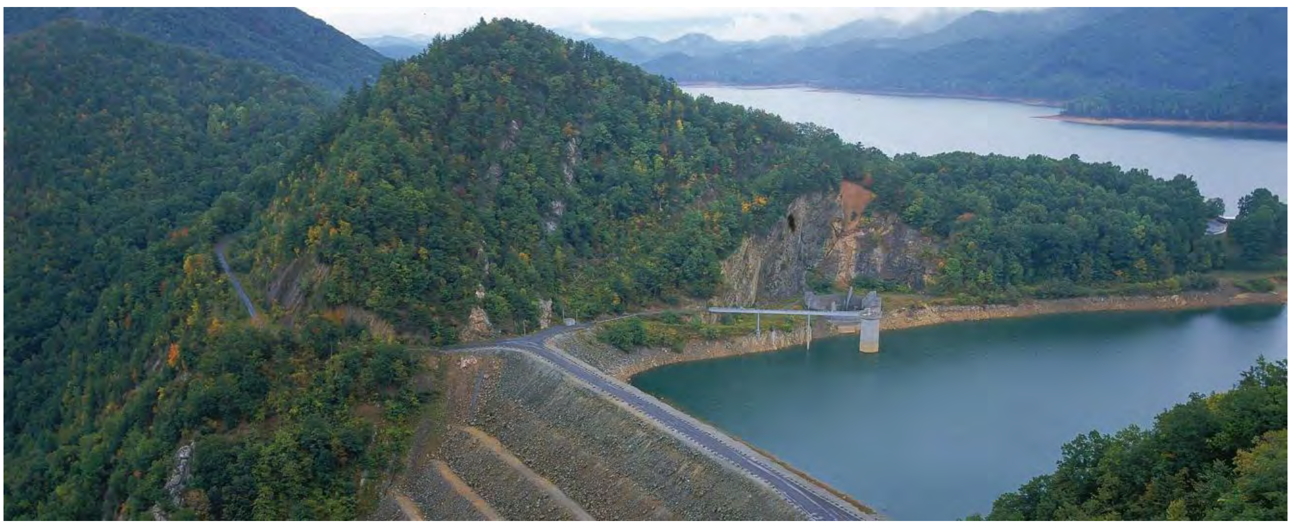
Figure 3.7. Norris Dam

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 3.8. 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 the planning area.

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 the planning area 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."

Changing Future Conditions

Since dam failure is heavily reliant on other causes like design error, inadequate maintenance and upkeep, changing conditions are not directly related to dam failure. However, increased rainfall and flooding events are predicted to increase in future occurrences so it could potentially put a stress on dams and increase the likelihood of dam failure.

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 compared to 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)
Knox County School District	1-Unlikely	2-Limited	2-Significant	1.55 (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 the planning area is presented in Table 3.5 below.

Table 3.5 Average Monthly Precipitation (inches), 1981-2010

Month	Precipitation
January	4.32in.
February	4.26in.
March	4.34in.
April	4.01in.
May	4.51in.
June	3.81in.
July	5.08in.
August	3.27in.
September	3.24in.
October	2.51in.
November	4.01in.
December	4.50in
Total	47.86in

Source: ncdc.noaa.gov, https://www.ncdc.noaa.gov/cdo-web/datatools/normals

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:

- *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.

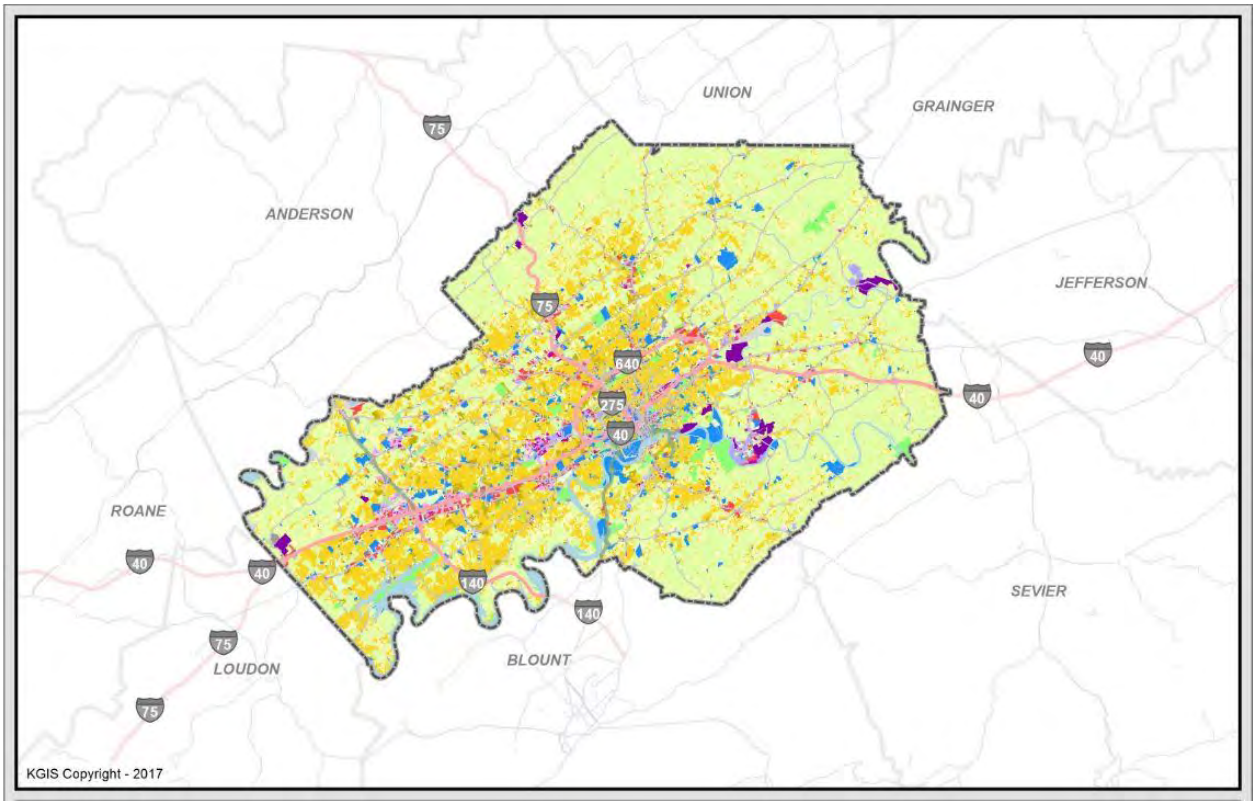
- *Agricultural drought* occurs when soil moisture is insufficient to meet the needs of a particular crop during its growing season. In Tennessee, an agricultural drought severely impacts crop, hay and nursery production. An agricultural drought would also stress lawns, golf courses, and athletic fields.
- *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 2012 Census of Agriculture, 65,347 acres in Knox County are used for agricultural purpose. This translates to 20 percent of the 325,120 land acres in the County. Figure 3.9 provides the current land use in Knox County. The lightest green areas are a mixture of agricultural, forested, and vacant land areas.

Figure 3.9. Knox County, Tennessee Land Use Map



Existing Land Use

- RR - Rural Residential
- SFR - Single Family Residential
- MF - Multifamily Residential
- CO - Commercial
- Office
- IND - Industrial (Manufacturing)
- Mining and Landfills
- WS - Wholesale
- P-QP - Public/Quasi Public Land
- AgForVac - Agriculture/Forestry/Vacant Land
- PP - Public Parks
- P-REC - Private Recreation
- OT - Under Construction/Other Uses
- H2O - Water
- ROW - Right of Way/Open Space
- TCU - Transportation/Communications/Utilit

Source: KGIS, Knox Maps, http://www.kgis.org/kgismaps/map.htm
Disclaimer: KGIS makes no representation or warranty as to the accuracy of this map and its information nor to its fitness for use. Any user of this map product accepts the same AS IS, WITH ALL FAULTS, and assumes all responsibility for the use thereof, and further covenants and agrees to hold KGIS harmless from and any damage, loss, or liability arising from any use of the map product. Independent verification of all information contained on this map should be obtained by any user.
Proprietary Information: This map product has been copyrighted by the KGIS Policy Board. The KGIS Policy Board hereby reserves all rights thereto, and no portion of the products or databases on this Web Site may be reproduced in any form or by any means without the express written authorization of the KGIS Policy Board or its authorized agents.

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

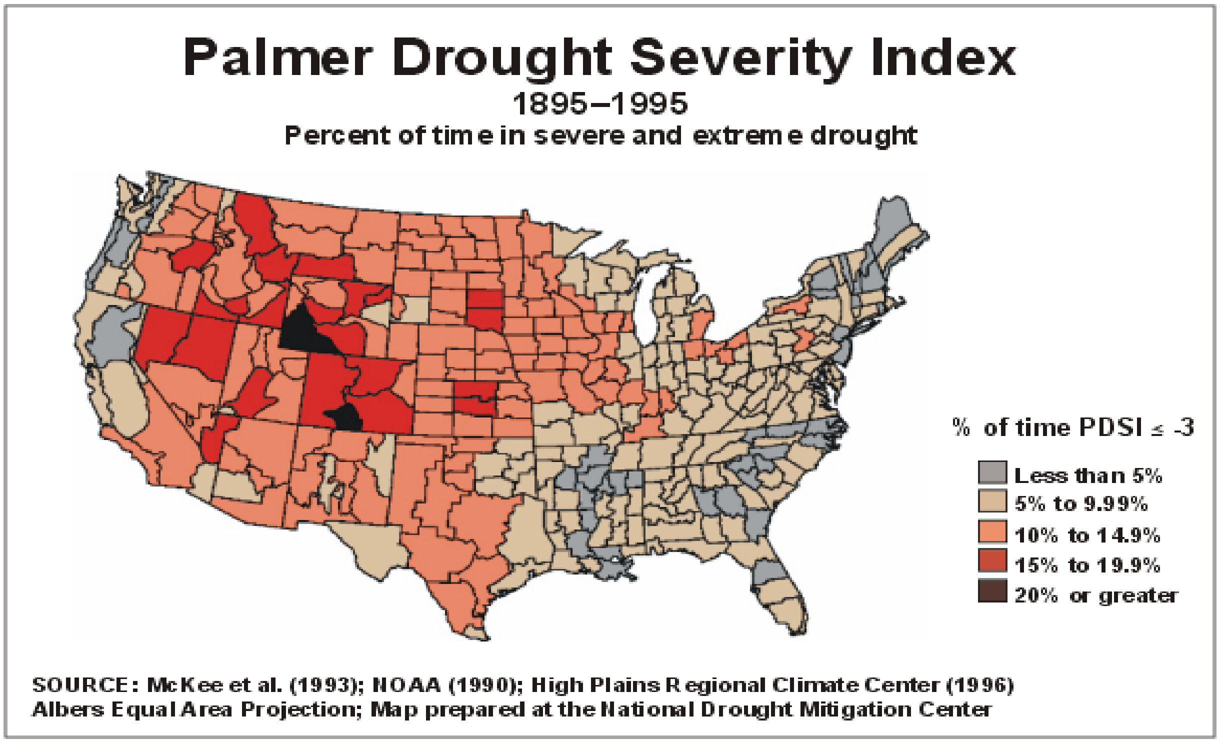
A common indicator of drought is the Palmer Drought Severity Index (PDSI). The PDSI is a soil moisture algorithm calibrated for relatively homogeneous regions. It is used by many U.S. government agencies and states to trigger drought relief programs. It was also the first comprehensive drought index developed in the United States. The classifications of the PDSI are presented in Table 3.6 below.

Table 3.6 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

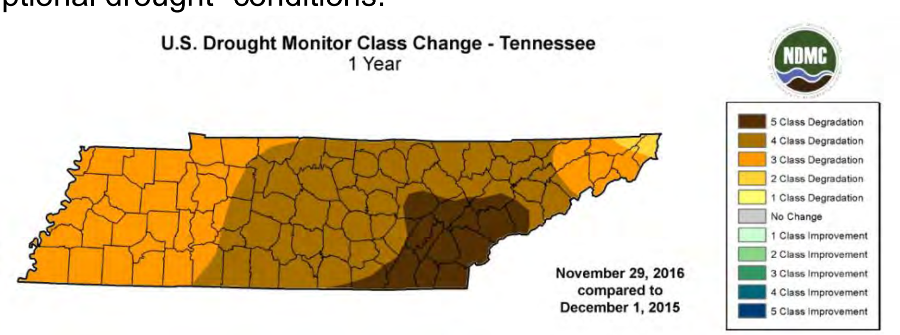
The PDSI indicates that for the period of 1895 through 1995 the eastern portion of Tennessee, including the planning area, was in a severe to extreme drought 5 to 9.99 percent of the time (Figure 3.10).

Figure 3.10. Palmer Drought Severity Index, 1895-1995



Historical information on previous periods of drought and drought impacts was obtained from the following 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.

- **2016**—Deficits of 12 inches of rain affected the region of Knox County along with higher than normal temperatures of 4 to 6 degrees. For several days in June, nearly 100% of the county was under "moderate drought" warnings. Again in November, nearly 100% of the county was under "extreme drought" warnings and 50% of the county was even experiencing "exceptional drought" conditions.



- **2014**—In June 2014, roughly 15% of Knox County was experiencing a "moderate drought" after a long time of not receiving much rain.
- **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 the planning area. 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 3.11 shows the impact of drought on Cherokee Lake which is upstream of Knox County.

Figure 3.11. 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 couldn'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 3.7 indicates the previous years as well as number of months each year from January 1950 to August 2017 when the Palmer Drought Severity Index was -3.00 or less. This index rating equates to severe and extreme drought. In total, during this 67- year period (804 months), eastern Tennessee was in severe to extreme drought for 65 months. This equates to 8.1 percent of the time.

Table 3.7 Years and Number of Months with PDSI ≤ -3.00, Tennessee-Eastern Climate Division

Year	Number of Months with PDSI ≤ -.3
2013	3 months
2012	9 months
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 2007 to 2016 totaled $8,871. According to the 2017 Tennessee Crop Insurance Profile, 83-percent of insurable crops were insured. Crop insurance claims as a result of drought during the 10-years period available are detailed in Table 3.8 below.

Table 3.8 Claims Paid in Knox County for Crop Loss as a Result of Drought (2007- 2016)

Year	Crop	Hazard	Claims Paid
2010	All Other Crops	Drought	$3,715
2007	All Other Crops	Drought	$5,156
		Total	**$8,871**

Source: USDA Risk Management Agency, 2017

Probability of Future Occurrences

Lack of precipitation for a given area is the primary contributor to drought conditions. Since precipitation levels year-to-year cannot be very accurately predicted in the long term, it is difficult to determine the probability of future occurrences of drought. The data available from NCDC for the 67-year period from 1950 to 2017 indicates that Eastern Tennessee, including Knox County experiences drought 8.1 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."

Changing Future Conditions

Typical characteristics of drought across the U.S. are altering due to a changing climate according to the National Oceanic and Atmospheric Administration (NOAA). Modeling from Oak Ridge National Laboratory suggests that future years will experience an average increase in the maximum number of consecutive dry days (precipitation less than 2.5mm) within the HUC 12 watersheds intersecting Knox County compared to the historical average. A changing future climate is more likely to result in droughts being drier than expected because of warmer temperatures increasing evaporation. Changing climate predications also show drought intensity and risk increasing.

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-Occasional	2-Limited	1-Limited	1.8 (Low)
Knox County (unincorporated)	2-Occasional	2-Limited	1-Limited	1.8 (Low)
City of Knoxville	2-Occasional	2-Limited	1-Limited	1.8 (Low)
Town of Farragut	2-Occasional	2-Limited	1-Limited	1.8 (Low)
Knox County School District	2-Occasional	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.

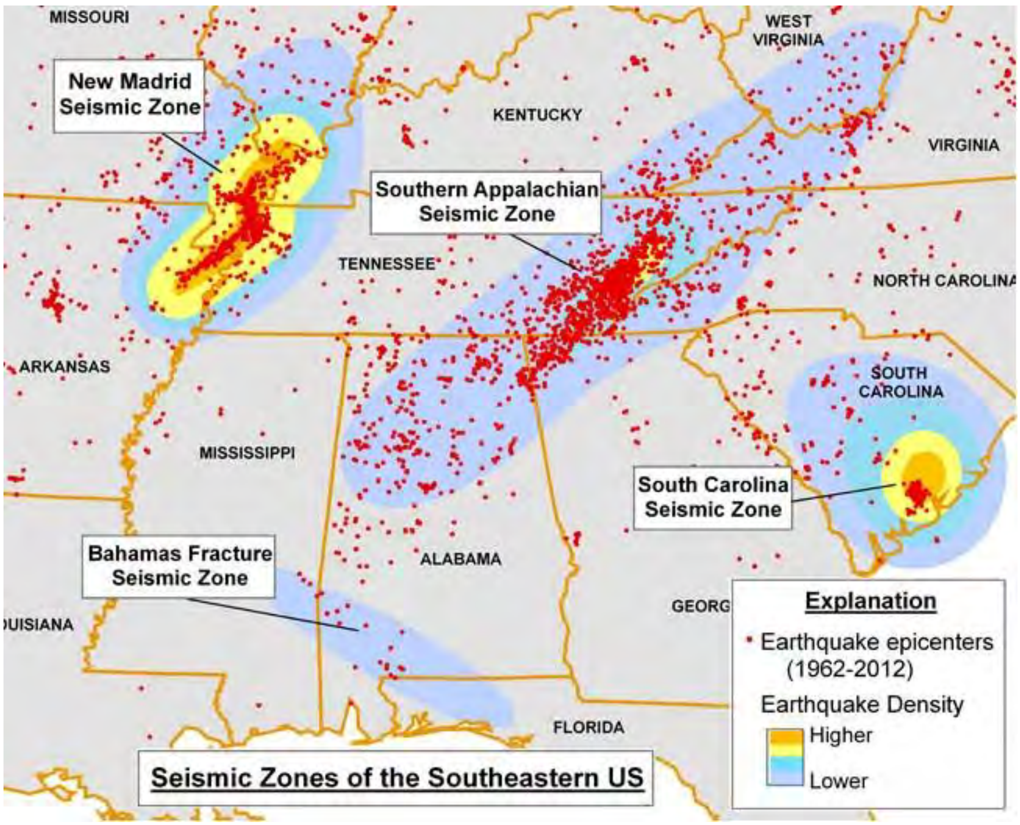
Table 3.9 Comparison of Richter Magnitude and Modified Mercalli Intensity Scales

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.

Figure 3.12. Central and Southeastern U.S. Seismic Zones

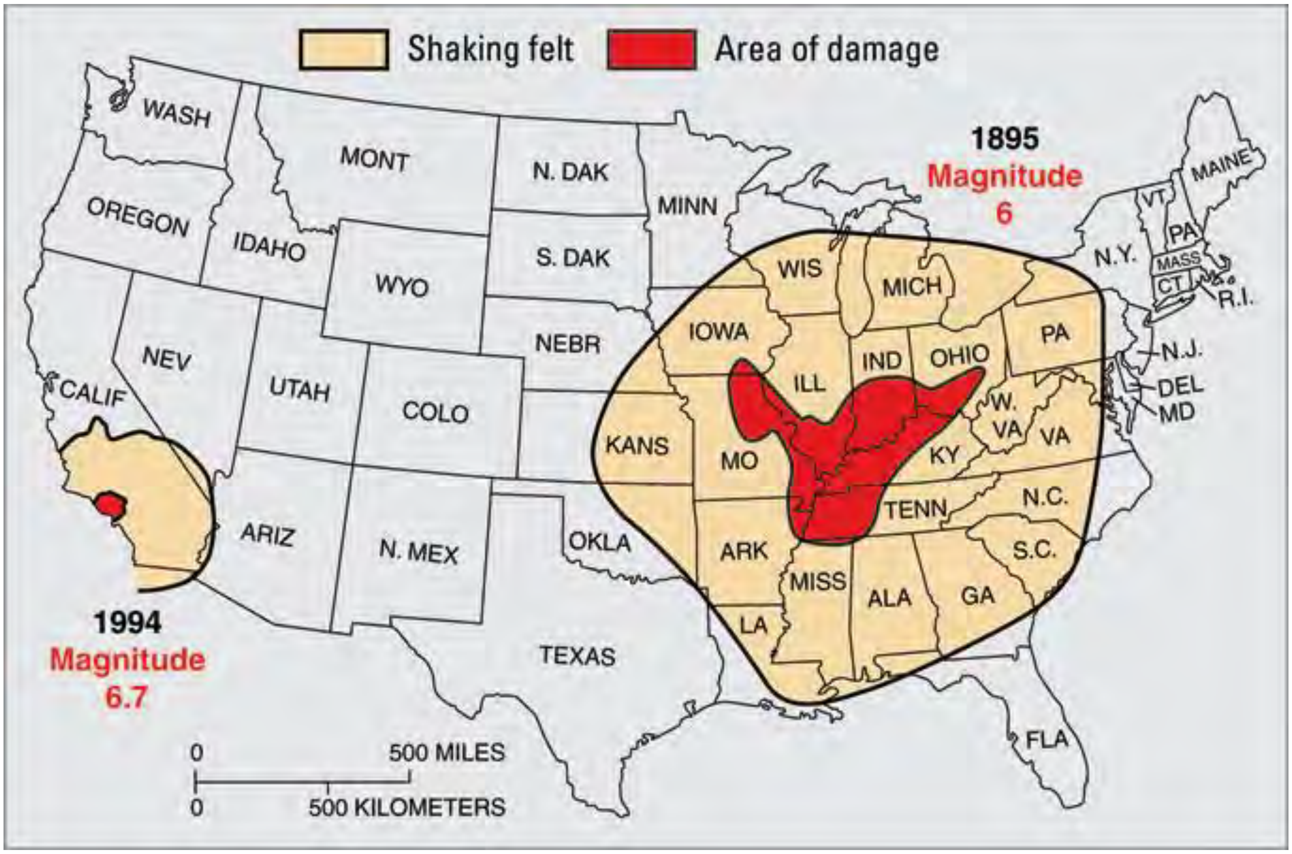


Source: Geological Survey of Alabama http://gsa.state.al.us/gsa/geologichazards/Quakes_AL.htm

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 3.12 above). Any earthquake originating here is likely to be extremely powerful, and its effects will most likely reach the planning area.

An earthquake affects a much larger area around the New Madrid Seismic Zone than an earthquake of a similar magnitude on the west coast due to the differences in the geology on the eastern part of the country. In Figure 3.13 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 being located in the yellow area, will feel the effects of a major New Madrid earthquake.

Figure 3.13. Variance of Areas Impacted by the Northridge, CA Earthquake and the Charleston, MO Earthquake.

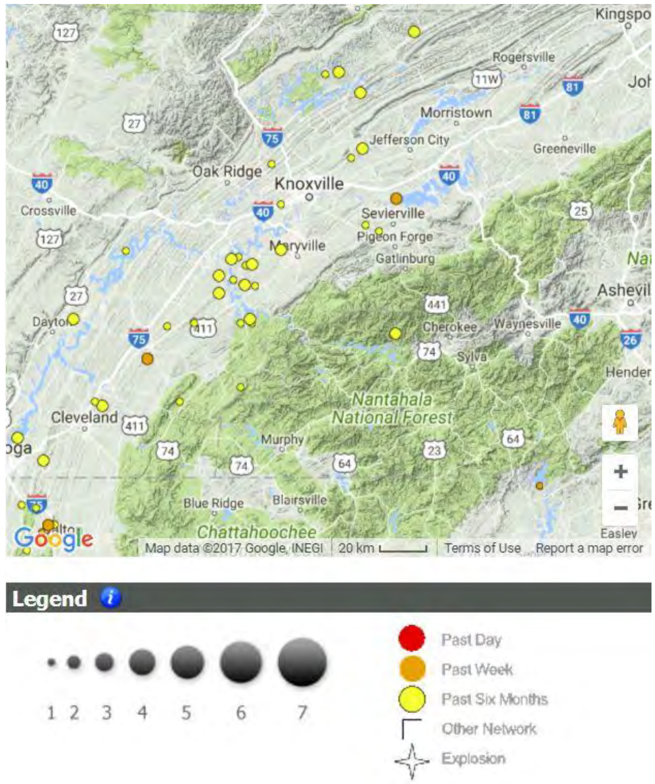


Source: Filson, J., McCarthy J., Ellsworth, !., M. Z., 2005, "The USGS Earthquake Hazards Program in NEHRP- Investing in a Safer Future", USGS. Fact Sheet 017-03. United States Geologic Survey.

Previous Occurrences

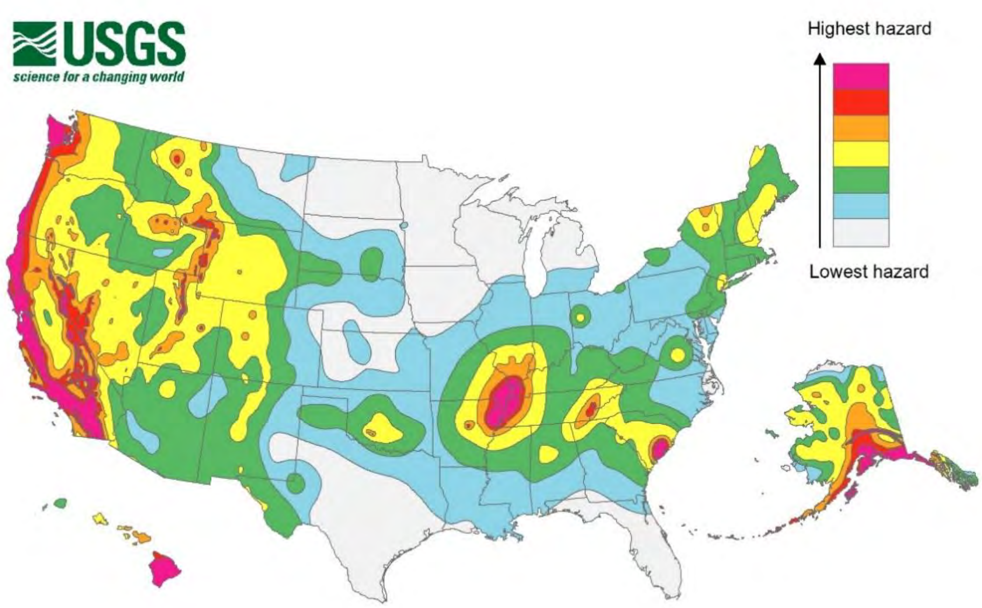
As stated, the East Tennessee Seismic Zone (ETSZ) is a very active seismic zone and there are numerous minor earthquakes within a 50-mile radius of Knox County. As shown in Figure 3.14 and Figure 3.15, the Center for Earthquake Research and Information at the University of Memphis has been recording earthquakes in central and southeast U.S. for several decades. Figure 3.14 displays the recent earthquake tremors in the Knox County vicinity within the six month timeframe of February 2017 to August 2017. The highest magnitude in the area was 2.7. Figure 3.15 shows the hazard areas for the entire U.S.

Figure 3.14. Recent Earthquakes in Central U.S. (February 2017 to August 2017)



Source: Center for Earthquake Research and Information at the University of Memphis
http://folkworm.ceri.memphis.edu/REQ3/html/index2.html

Figure 3.15. Hazard Map for Earthquakes



Source: USGS Earthquakes, https://earthquake.usgs.gov/hazards/hazmaps/conterminous/2014/images/HazardMap2014_lg.jpg

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 the planning area 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 173 years of recorded history in the planning area, there has been no significant structural damage from an earthquake. Since 1973, the USGS earthquake catalog notes 8 earthquakes within Knox County ranging from 2.6 to 3.7 magnitude. Earthquakes of this magnitude and less are usually not felt, but are recorded by seismographs. Some chimneys have fallen over, windows have been broken, things have fallen off shelves, pictures have fallen from 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 the planning area. 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.

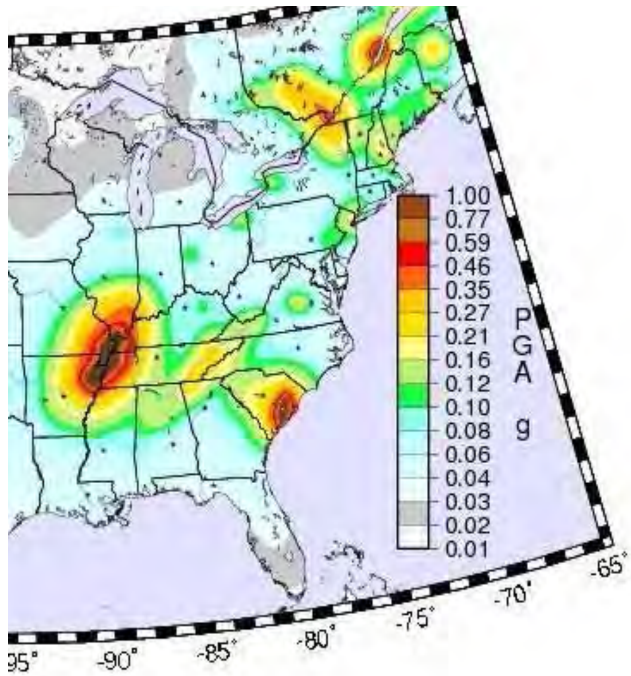
Probability of Future Occurrences

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.

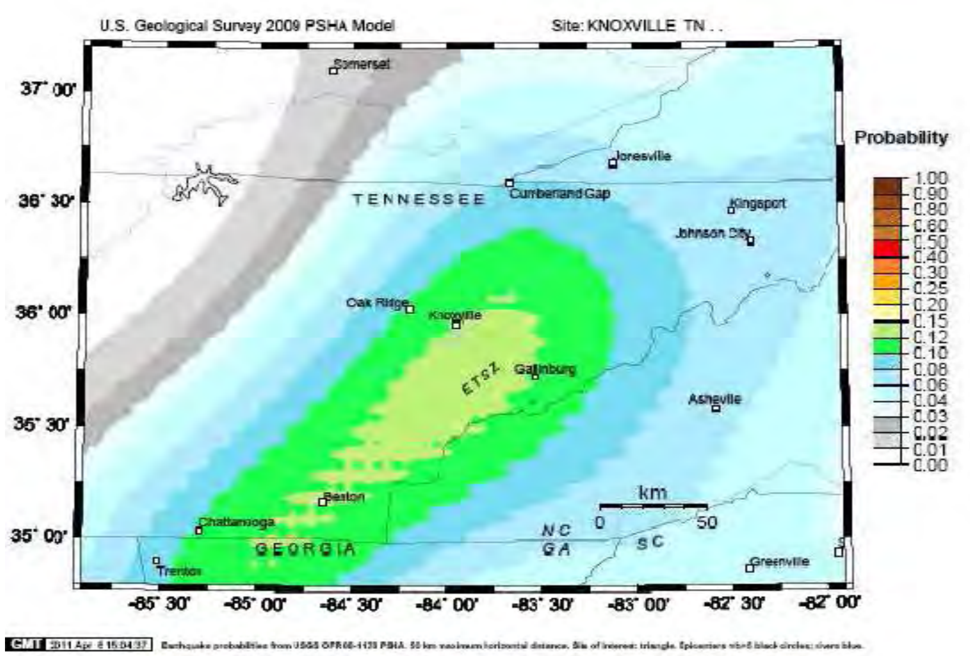
Figure 3.16 indicates that there is a 27 percent probability of an earthquake exceeding peak acceleration of two percent gravity in the next 50 years in the planning area. Figure 3.17 with U.S. Geological Survey data, it depicts a 10-12 percent probability of a 5.0 (Modified Mercalli Intensity Scale VI-VII) or greater earthquake occurring in the next 100 years. In reference to previous occurrences, there have been 3 earthquakes since 1973 within the planning area that were greater than a 3.0 magnitude, thus based on this 44-year period there is a 6.8 percent probability of occurrence. In reviewing all probabilistic data, HMPC determined that the probability of earthquakes in the planning area should be categorized as “occasional”.

Figure 3.16. Peak Ground Acceleration—2 Percent Probability of Exceedance in 50 Years



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

Figure 3.17. 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 173 years of recorded history in the planning area, 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 have been retrofitted or designed to withstand earthquakes. If a greater magnitude earthquake occurs, structural damage could exist in the 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.

Changing Future Conditions

The relationship between earthquakes and changing climate conditions is still very new research. However, early research suggests increased flooding and rain causing landslides and erosion could potentially increase fault activities by reducing the weight on a fault or by loosening fault planes, allowing it to move more easily. If precipitation increases to more frequent torrential rain events, the risk of earthquakes could also potentially increase.

Earthquake Hazard Summary

	Probability	Magnitude	Spatial Extent	Ranking
Planning Area Overall	2-Occasional	1-Negligible	3- Extensive	1.85 (Low)
Knox County (unincorporated)	2-Occasional	1-Negligible	3- Extensive	1.85 (Low)
City of Knoxville	2-Occasional	1-Negligible	3- Extensive	1.85 (Low)
Town of Farragut	2-Occasional	1-Negligible	3- Extensive	1.85 (Low)
Knox County School District	2-Occasional	1-Negligible	3- Extensive	1.85 (Low)

3.2.4 Expansive Soils

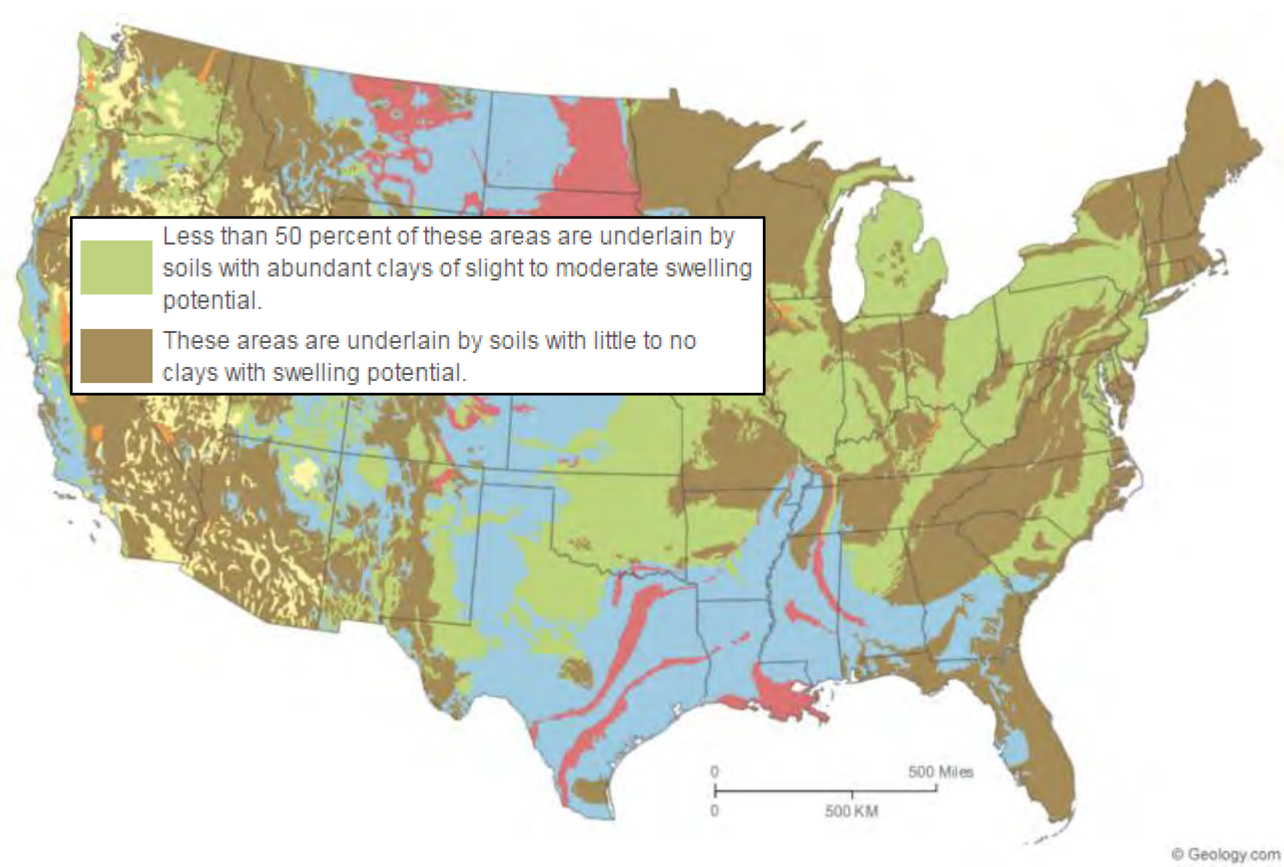
Description

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 3.18 shows a map of the United States depicting areas containing varying degrees of expansive soils. The planning area is located in the brown shaded area underlain by soils with little to no clays with swelling potential of soils when compared to the rest of the United States.

Figure 3.18. Expansive Soils Map



Source: 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.

Changing Future Conditions

It is shown that a significant increase in predicted soil movement is expected with climate change. Therefore, a continuing revision of footing design standards is advised in order to cater to the effects of climate change. However, within Knox County there is limited amounts of clay soil so even with a changing climate it is unlikely that damage or frequency of events would increase or decrease.

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)
Knox County School District	1-Unlikely	1-Negligible	1-Limited	1.00 (Low)

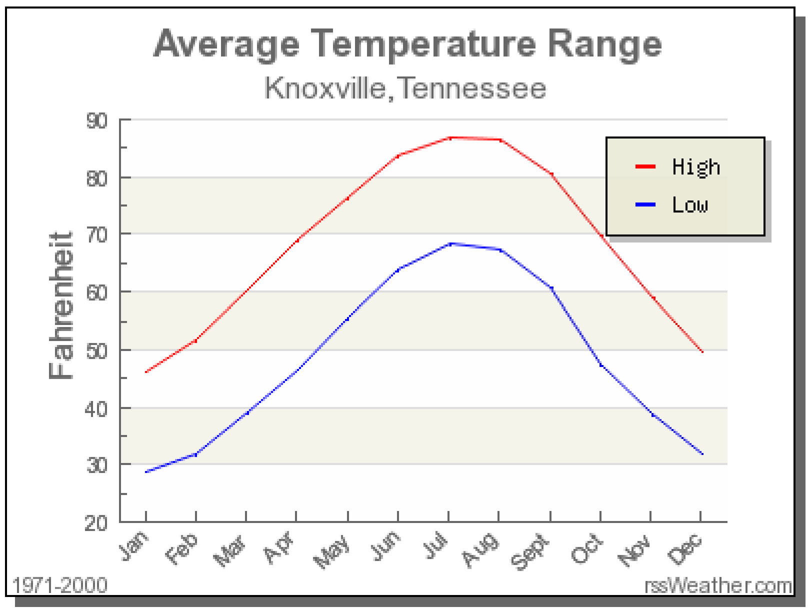
3.2.5 Extreme Temperatures

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 the planning area 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 3.10 and are similar for the entire planning area.

Table 3.10 Average Monthly Temperatures for Knoxville, Tennessee 1981-2010

Month	Low	High
Jan	29.2°F	47.3°F
Feb	32.4°F	52.3°F
Mar	39.2°F	61.4°F
Apr	47.3°F	70.3°F
May	56.2°F	78.1°F
Jun	64.7°F	85.4°F
Jul	68.7°F	88.2°F
Aug	67.8°F	87.8°F
Sept	60°F	81.8°F
Oct	49°F	71.2°F
Nov	39°F	60.4°F
Dec	32°F	49.8°F



https://www.ncdc.noaa.gov/cdo-web/datatools/normals; http://www.rssweather.com/climate/Tennessee/Knoxville/

Extreme Heat

FEMA has defined 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. 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 effects of humidity are added to high temperature. Table 3.11 presents heat index values and their potential physical effects.

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.

It should be noted, however, that negative effects of extreme heat may be experienced by portions of the population even when temperatures do not officially trigger a National Weather Service Heat Advisory.

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. Also at risk are those without adequately cooled or ventilated shelter or housing, especially during instances when nighttime temperatures remain above elevated. Also, during extreme heat events, infrastructure, energy sources in particular, can be stressed, and long-term extreme heat can stress water sources, particularly if occurring during a period of drought.

Table 3.11 Heat Index Values and Effects

Classification	Heat Index	Effect on the body
Caution	80°F - 90°F	Fatigue possible with prolonged exposure and/or physical activity
Extreme Caution	90°F - 103° F	Heat stroke, heat cramps, or heat exhaustion possible with prolonged exposure and/or physical activity
Danger	103°F - 124°F	Heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity
Extreme Danger	125°F or higher	Heat stroke highly likely

Source: National Weather Service, Heat Index Chart, http://www.srh.noaa.gov/ama/?n=heatindex

Extreme Cold

The National Weather Service will issue a Wind Chill Advisory for Knox County when temperatures are expected to reach –5°F to –14°F and winds of greater than 10 mph for at least 3 hours. 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 (10m);
* 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).

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; household fires, which can be caused by fireplaces and emergency heaters; and frozen/burst pipes.

Figure 3.19 shows the relationship of wind speed to apparent temperature and typical time periods for the onset of frostbite.

Figure 3.19. Wind Chill Chart

Wind (mph) \ Temperature (°F)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes; 10 minutes; 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

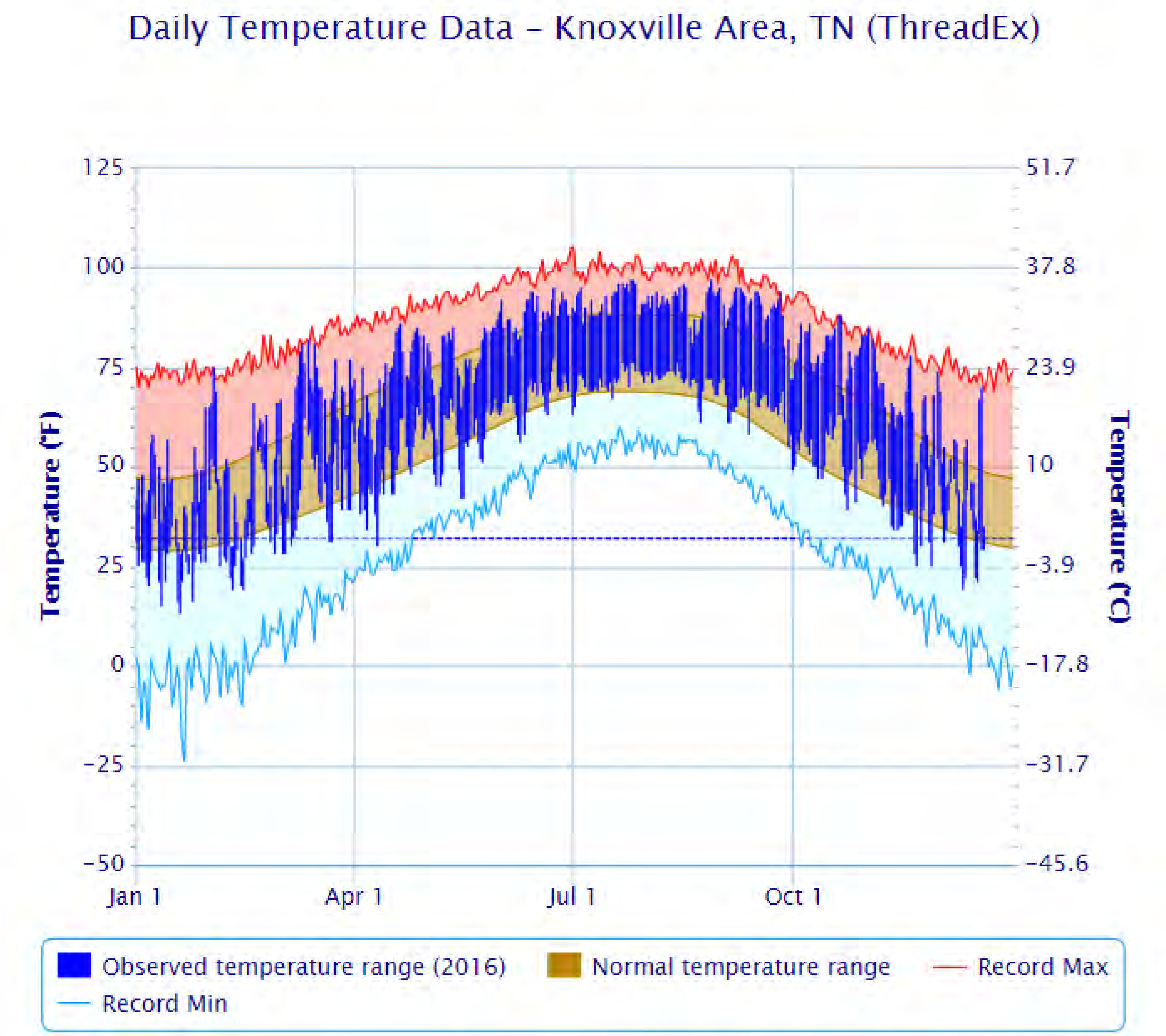
Source: National Weather Service

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. Figure 3.20 indicates the daily temperature data for Knoxville for the year 2016. The brown band shows the normal temperature range throughout the year. This is the temperature that is expected, but the dark blue line is the actual observed temperature for the year. The red line is the record max and the light blue is the record low. Multiple times in October, the actual observed temperature broke the record maximum temperature. Also the observed temperature for the year expanded outside of the normal temperature range for most months of the year.

Figure 3.20. Daily Temperature for Knoxville Area, 2016



Source: NOWData, NOAA Online Weather Data, NWS Morristown, TN http://w2.weather.gov/climate/xmacis.php?wfo=mrx

Previous Occurrences

Analysis of daily maximum temperatures recorded at the Knoxville McGhee Tyson Airport, station ID 404950 revealed that during the 67-year period from January 1, 1950 to August 23, 2017, 2,304 days had a high temperature exceeding 90 degrees Fahrenheit. This translates to just over 9 percent of the days during that time period. Thirty-seven days in this time period had a high temperature of 100 degrees Fahrenheit or higher.

The record high temperature at this station is 105 degrees Fahrenheit which occurred July 1, 2012. Table 3.12 summarizes the daily maximum temperatures from January 1, 1950 through August 23, 2017 that were 100 degrees Fahrenheit or higher.

Table 3.12 Daily Maximum Temperature 100 Degrees Fahrenheit or Higher, January 1, 1950-August 23, 2017, Knoxville McGhee Tyson Airport

Date	High Temperature (degrees Fahrenheit)	Date	High Temperature (degrees Fahrenheit)
6/30/2012	105	8/17/1988	101
7/01/2012	105	8/18/1988	101
7/27/1952	103	8/16/2007	101
7/28/1952	103	6/28/2012	101
9/5/1954	103	9/1/1951	100
6/24/1988	102	6/28/1952	100
7/9/1988	102	6/30/1952	100
8/23/2007	102	7/22/1952	100
6/29/2012	102	6/27/1954	100
6/27/1952	101	7/1/1954	100
7/23/1952	101	9/7/1954	100
7/29/1952	101	7/16/1980	100
7/14/1954	101	8/10/1980	100
9/4/1954	101	6/23/1988	100
9/6/1954	101	7/8/1993	100
7/17/1980	101	7/28/1993	100
8/21/1983	101	8/16/1995	100
6/26/1988	101	8/24/2007	100
7/8/1988	101		

Analysis of daily minimum temperatures recorded at the Knoxville McGhee Tyson Airport, station ID 404950 revealed that during the 67-year period from January 1, 1950 to August 23, 2017, 168 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 3.13 summarizes the daily minimum temperatures from January 1, 1950 through August 23, 2017 that were zero degrees Fahrenheit or lower.

Table 3.13 Daily Minimum Temperature Zero Degrees Fahrenheit or Lower, January 1, 1950-August 23, 2017, 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
1/29/2014	-1

The following section summarizes three previous extreme temperature events in the planning area in the 22-year period from 1995 to 2017. Information on these events came from the National Climatic Data Center. Of the historical events summarized; all were extreme heat events. NCDC did not report any extreme cold events.

- **June/July, 2012, Extreme Heat Event**—A large heat wave moved through the southeastern U.S. and had large effects on Knox County. Though no fatalities were reported, the all-time max-high temperature record was broken at 105 degrees Fahrenheit.
- **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 the planning area as a result of extreme heat from 2007 to 2016. However, there were $28,825 in crop losses as a result of frost and freeze conditions, as detailed in the table below.

Table 3.14 Claims Paid in Knox County for Crop Loss as a Result of Frost/Freeze (2007- 2016)

Year	Crop	Hazard	Claims Paid
2015	All Other Crops	Freeze	$13,430
2014	All Other Crops	Frost	$1,632
2011	All Other Crops	Frost	$388
2011	All Other Crops	Freeze	$388
2009	All Other Crops	Freeze	$12,987
		Total	**$28,825**

Source: USDA Risk Management Agency, 2017

Probability of Future Occurrences

Based on historical maximum and minimum temperatures recorded at the Knoxville McGhee Tyson Airport from January 1, 1950 to August 23, 2017, temperatures above 90 degrees Fahrenheit occurred an average of 34 times each year while temperatures below 10 degrees Fahrenheit occurred an average of 2.5 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."

Changing Future Conditions

Average temperatures across the Southeast have increased by an average of 2°F from 1970 to the present, with higher average temperatures during summer months. In particular, the warm minimum temperature has been increasing meaning that during warmer parts of the year, the coldest days are getting warmer. This is important because human health relies on cooler nights, and reduced cooling of overnight temperatures may create additional health stresses for local vulnerable populations. Changing future conditions also influence heat waves. Models predict there will be more heat wave events and they will last longer with more consecutive days. Modeling outputs specific to Knox County suggest a clear increase in the number of days in which maximum temperature exceeds 95ºF, with an average of 20-80 more days above 95ºF by 2100 when compared to a 1950-2004 reference baseline.

With changing future conditions, it is predicted that there will be a decrease in cold air outbreaks. Modeling outputs specific to Knox County suggest a decrease in the number of days on which minimum temperatures fall below 32ºF, with an average of approximately 30-55 fewer days reaching below 32ºF by 2100 when compared to a 1950-2004 reference baseline.

Extreme Temperatures 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)
Knox County School District	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 of low-lying ground adjacent to a river, formed mainly of river sediments and subject to flooding is defined as the floodplain. The area inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year is defined as the special flood hazard area (SFHA). The SHFA or 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

The planning area 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.

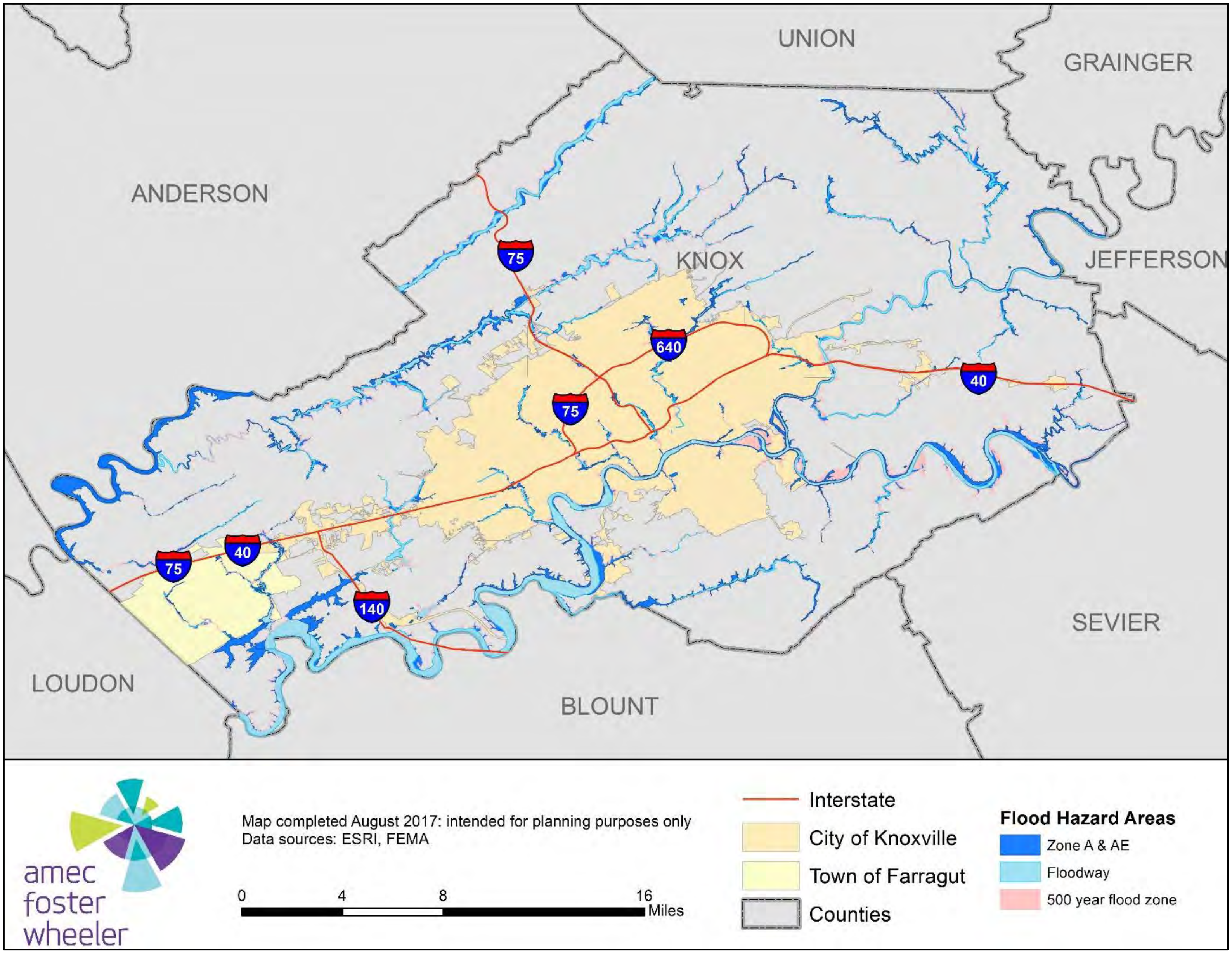
Riverine Flooding

The series of maps in Figure 3.21 to Figure 3.23 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 effective Flood Insurance Rate Map (FIRM) database for Knox County. The FIRM database is the digital, geospatial version of the flood hazard information shown on the published paper FIRMs. The FIRM Database depicts flood risk information and supporting data used to develop the risk data.

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.

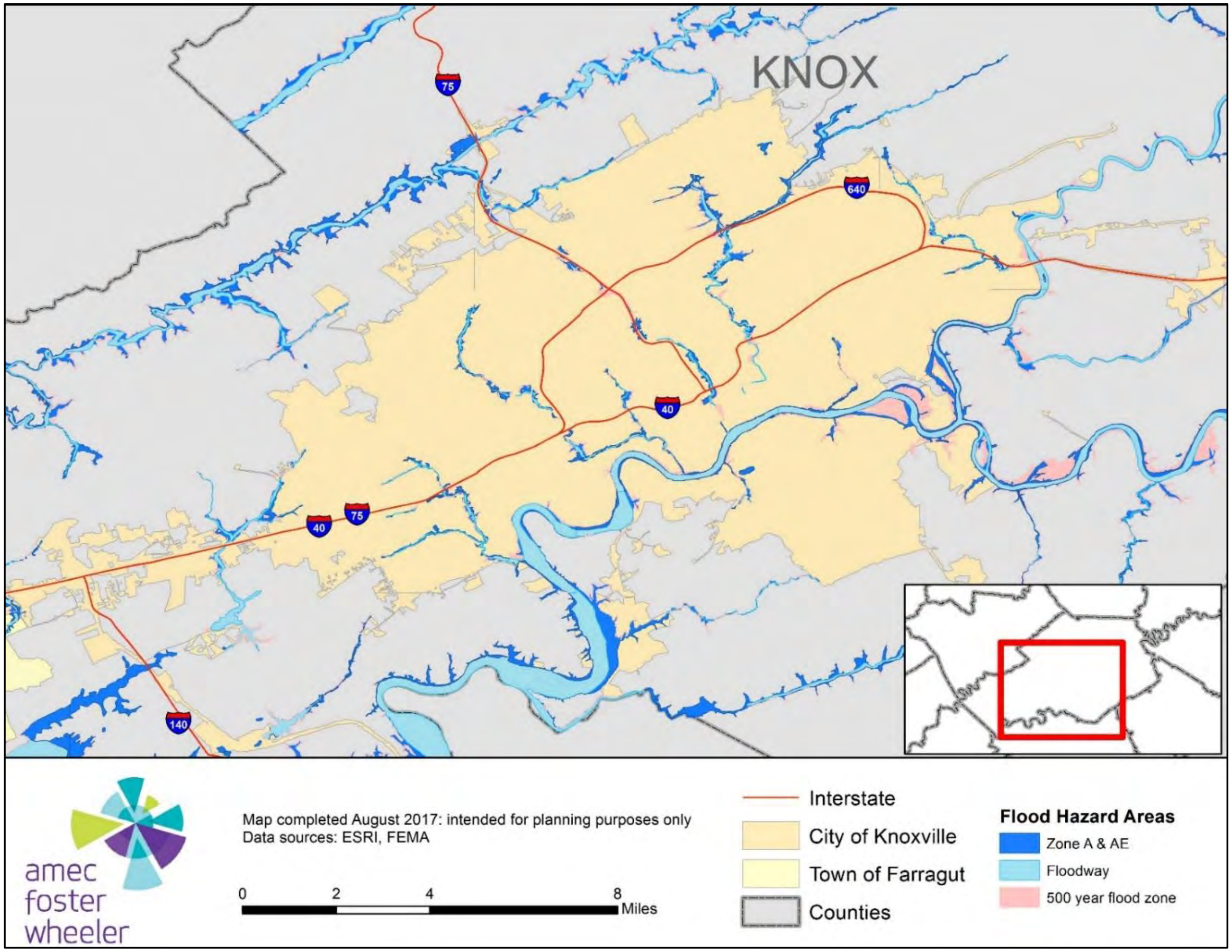
Figure 3.21. Knox County HAZUS/DFIRM 1-Percent Annual Chance Floodplain



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.

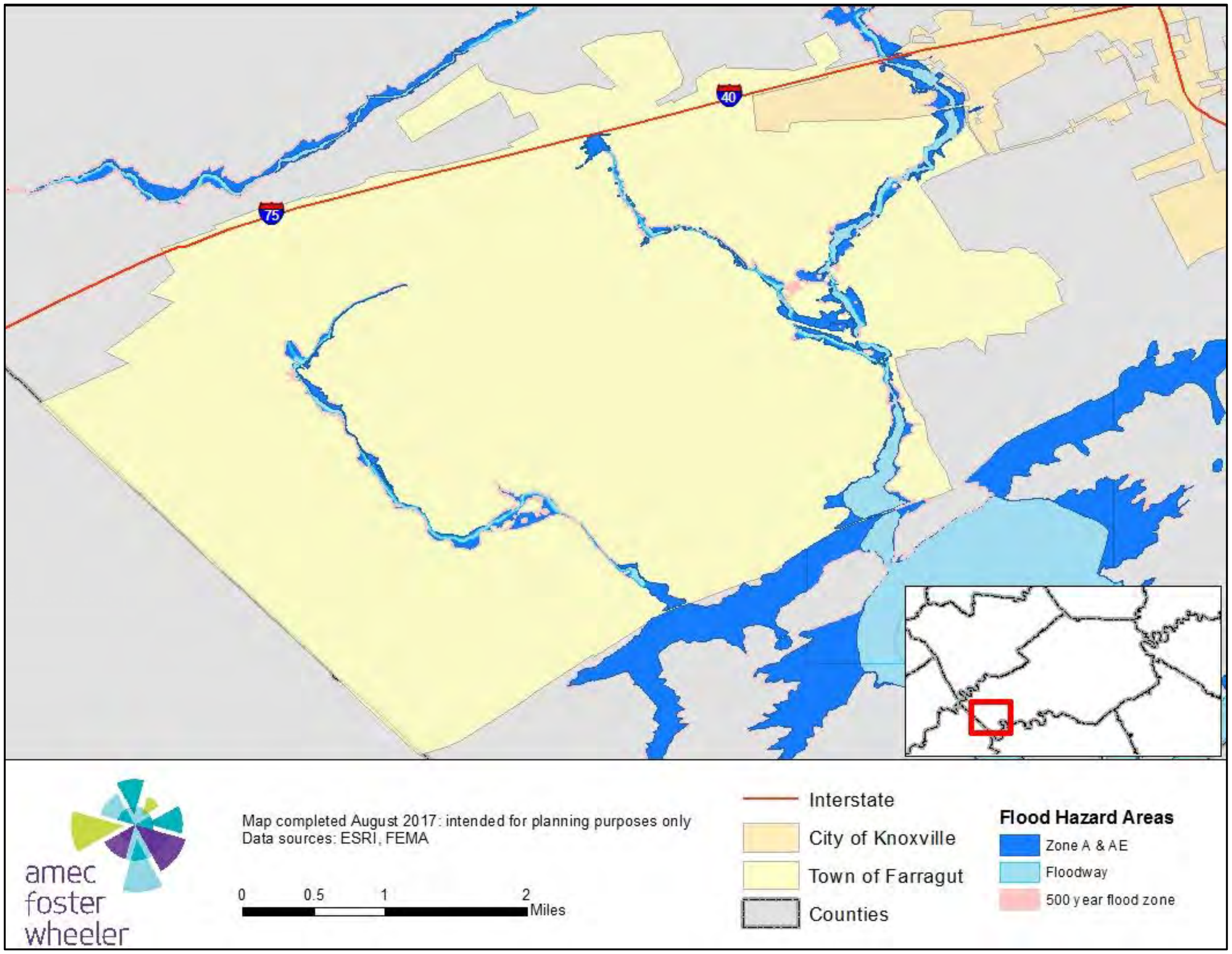
Figure 3.22. City of Knoxville HAZUS/DIRM 1-Percent Annual Chance Floodplain



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.

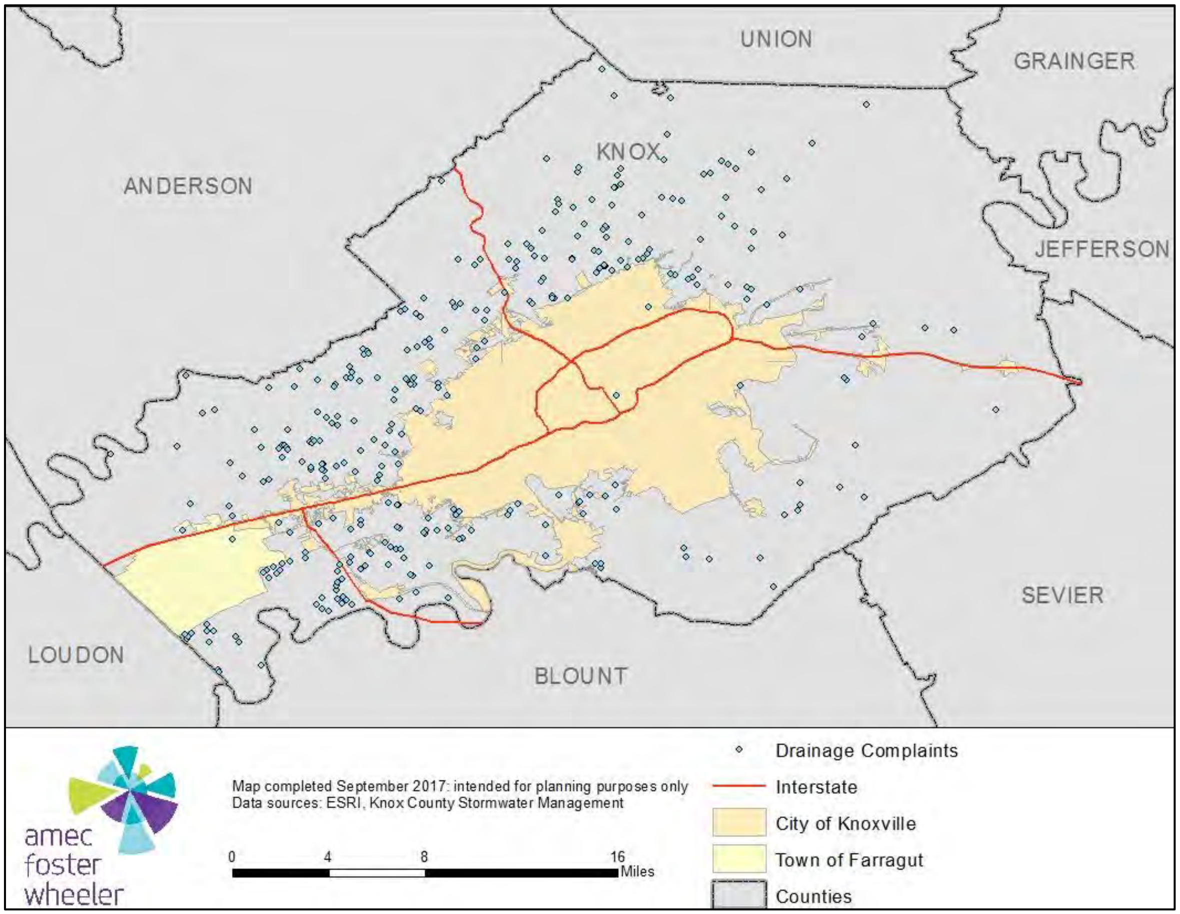
Figure 3.23. Town of Farragut HAZUS/DFIRM 1-Percent Annual Chance Floodplain



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 3.24 depicts locations within the planning area that have received drainage system complaints. However, it should be noted that flash floods can occur throughout the planning area if intense rainfall occurs.

Figure 3.24. Drainage Complaints 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 3.25 and Figure 3.26 shows locations within the Ten Mile Creek Drainage Basin that could be flooded if the outlet is plugged.

Figure 3.25. Ten Mile Creek Sinkhole Flooding

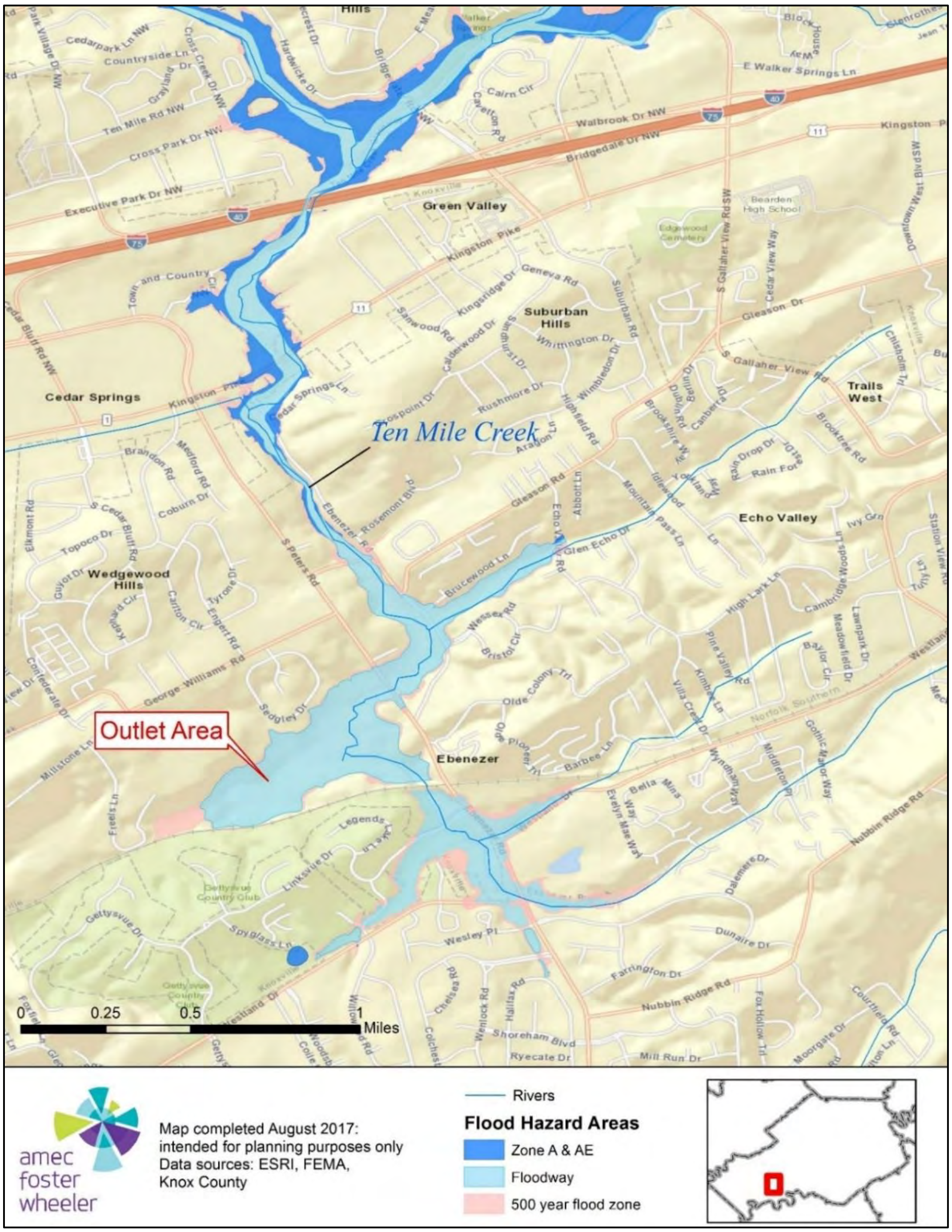
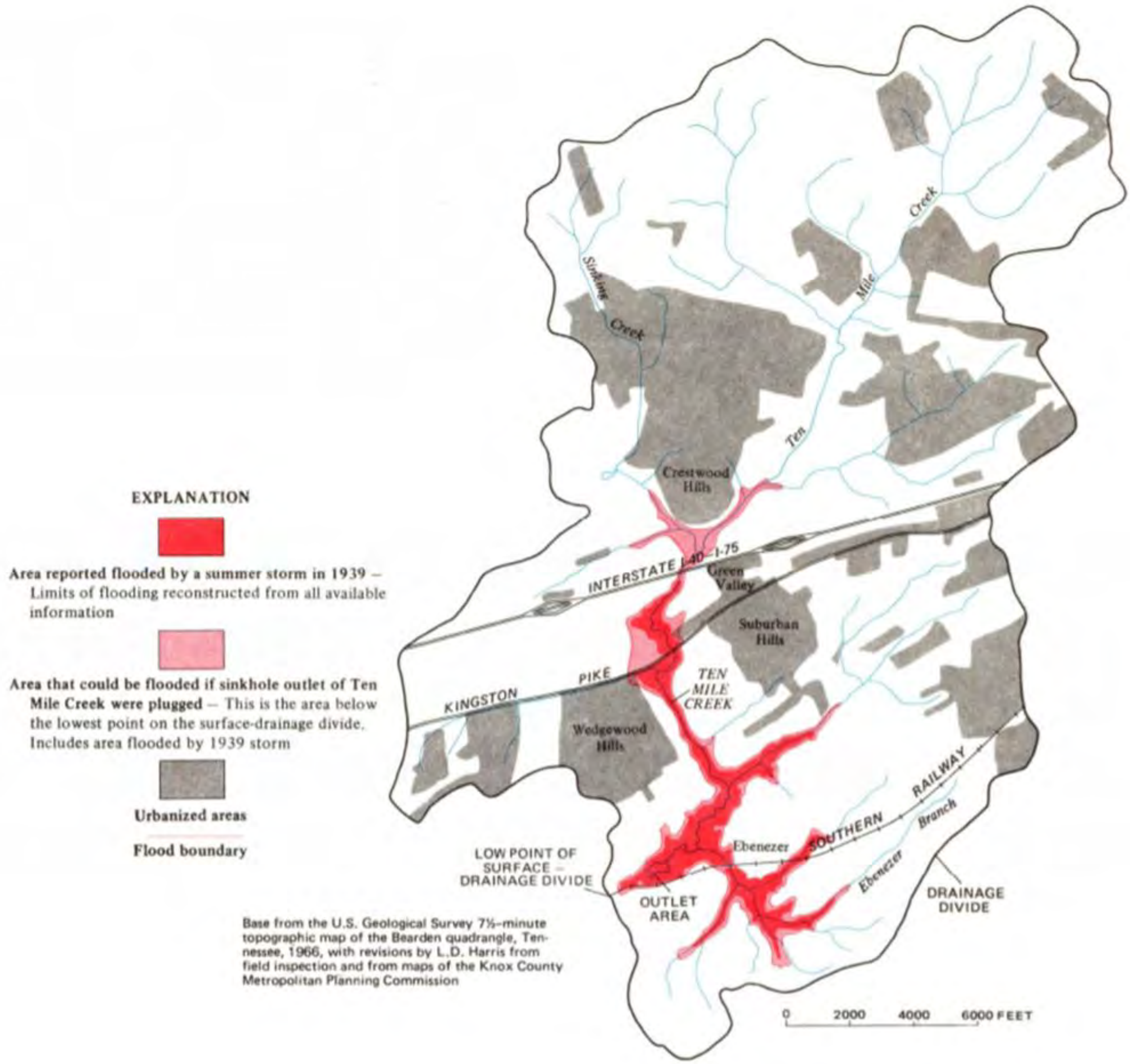


Figure 3.26. Ten Mile Creek Drainage Basin



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, 2017

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	8/05/2013	602	165,516,600	137	1,439,397.99
City of Knoxville	Participating Regular-4/30/1971	Y Class 8	8/05/2013	380	108,754,800	244	3,915,920.23
Town of Farragut	Participating Regular-7/23/1971	N	8/05/2013	60	18,526,800	8	113,428.61

Repetitive Loss Properties

There are a total of 18 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), 2017

	AE, A1-30, AO, AH, A	VE, V1-30, V	B, C, X	TOTAL
RL Buildings (Total)	8	0	10	18
RL Buildings (Insured)	7	0	5	12
RL Losses (Total)	18	0	27	45
RL Losses (Insured)	16	0		30
RL Payments (Total)	$129,754.54	$.00	$415,272.04	$545,026.58
Building	$106,540.12	$.00	$355,071.64	$461,611.76
Contents	$23,214.42	$.00	$60,200.40	$83,414.82
RL Payments (Insured)	$116,108.78	$.00	$301,533.00	$417,641.78

	AE, A1-30, AO, AH, A	VE, V1-30, V	B, C, X	TOTAL
Building	$92,894.36	$.00	$248,017.38	$340,911.74
Contents	$23,214.42	$.00	$53,515.62	$76,730.04

City of Knoxville

There are a total of 36 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, 2017

	AE, A1-30, AO, AH, A	VE, V1-30, V	B, C, X	TOTAL
RL Buildings (Total)	27	0	9	36
RL Buildings (Insured)	13	0	6	19
RL Losses (Total)	78	0	29	107
RL Losses (Insured)	35	0		57
RL Payments (Total)	$1,033,272.45	$.00	$1,424,408.01	$2,457,680.46
Building	$885,661.49	$.00	$976,505.86	$1,862,167.35
Contents	$147,610.96	$.00	$447,902.15	$595,513.11
RL Payments (Insured)	$416,672.68	$.00	$1,306,515.90	$1,723,188.58
Building	$395,812.06	$.00	$946,426.12	$1,342,238.18
Contents	$20,860.62	$.00	$360,089.78	$380,950.40

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.

Table 3.18 Repetitive Loss Properties and Statistics, Town of Farragut, 2017

	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	0	0
RL Losses (Total)	0	0	3	3

	AE, A1-30, AO, AH, A	VE, V1-30, V	B, C, X	TOTAL
RL Losses (Insured)	0	0		0
RL Payments (Total)	$.00	$.00	$30,397.73	$30,397.73
Building	$.00	$.00	$30,187.33	$30,187.33
Contents	$.00	$.00	$210.40	$210.40
RL Payments (Insured)	$.00	$.00	$.00	$.00
Building	$.00	$.00	$.00	$.00
Contents	$.00	$.00	$.00	$.00

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 42 separate reported flood events in Knox County between 1997 and 2017. Of the 42 events,19 were reported as river floods. The remaining 23 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 $13.368 Million in property damages.

In addition, Knox County has been included in nine Presidential disaster declarations that included flooding between 1953 and 2017. For five of those declarations (DRs 1464, 1331, 424, 1974, and 4005), 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.

- **May 27, 2017, Severe Storms and Flooding**—Severe storms came through east Tennessee causing thousands of dollars in damage. Governor Bill Haslam requested federal aid for cleanup and recovery for 12 counties, including Knox County.
- **April 22, 2017**—A low pressure moved into the central plains moving a surface front southeastward towards middle Tennessee. This placed the upper Tennessee Valley in a warm and humid air mass, which aided in the generation of heavy rainfall and severe storms for several days. Beaver Creek went out of its bank, with water reaching the skirting of a mobile home.
- **February 15-23, 2015, Winter Storm and Flooding**—A severe winter storm affected much of east Tennessee, including Knox County, causing intense flooding. There were 30 casualties through this storm.
- **April 2-5, 2012, Flash Flooding**—Severe weather caused flash flooding in the

planning area during these days.

- **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 3.27. February 28, 2011 Flash Flooding

Source: http://archive.knoxnews.com/news/local/flash-floods-hit-knoxville-area-roads-swamped-closed-ep-406052325-358050181.html/

- **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, Flood**—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-Sentinel at $1.2 to $2 million. 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 2007 to 2016 totaled $168,126. According to the 2017 Tennessee Crop Insurance Profile, 83 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, 2007-2016

Year	Crop	Hazard	Claims Paid
2015	All Other Crops	Excess Moisture/Precip/Rain	$15,075.00
2015	All Other Crops	Excess Moisture/Precip/Rain	$-
2015	All Other Crops	Excess Moisture/Precip/Rain	$4,145.00
2014	All Other Crops	Excess Moisture/Precip/Rain	$3,985.00
2014	All Other Crops	Excess Moisture/Precip/Rain	$5,790.00
2011	All Other Crops	Excess Moisture/Precip/Rain	$433.00
2011	All Other Crops	Excess Moisture/Precip/Rain	$85,948.00
2011	All Other Crops	Excess Moisture/Precip/Rain	$25,625.00
2010	All Other Crops	Excess Moisture/Precip/Rain	$6,249.00
2009	All Other Crops	Excess Moisture/Precip/Rain	$19,480.00
2009	All Other Crops	Excess Moisture/Precip/Rain	$1,396.00
		Total	**$168,126**

Source: USDA Risk Management Agency, 2017

Probability of Future Occurrences

Based on data from FEMA, the NCDC database and local accounts, from 1997 to 2017, there were 42 records of flood or flash flood events over a 10-year period. The average number of flood and flash flood events calculates to 4.2 per year. Therefore, the probability of future occurrences for flooding is "highly likely."

Magnitude/Severity

The floodplain extends into some populated areas of the planning area 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.”

Changing Future Conditions

Temperatures across the county, region, and world have increased in recent decades, and models suggest that this trend will continue. Although future precipitation patterns are very difficult to predict, a general increase in temperatures is expected to increase the frequency of heavy precipitation events because of increased evaporation and the ability of warmer air to hold more moisture. Increasing frequency and intensity of heavy rainfall is expected, which may increase the risk of flooding. Modeling from Oak Ridge National Laboratory suggests that future years will experience an average increase in the annual number of very heavy precipitation days (precipitation greater than 0.8 inches) within the HUC 12 watersheds intersecting Knox County compared to the historical average.

The combination of heavy rain, urban sprawl into flood-prone areas, and poor urban infrastructures that do not aid in absorbing excess rainfall will exacerbate flood damages. This will result in an increase in the scale, intensity and duration of floods.

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 36 in the City of Knoxville and 18 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)
Knox County School District	4-Highly Likely	2-Limited	3-Extensive	3.1 (High)

3.2.7 Land Subsidence/Sinkholes

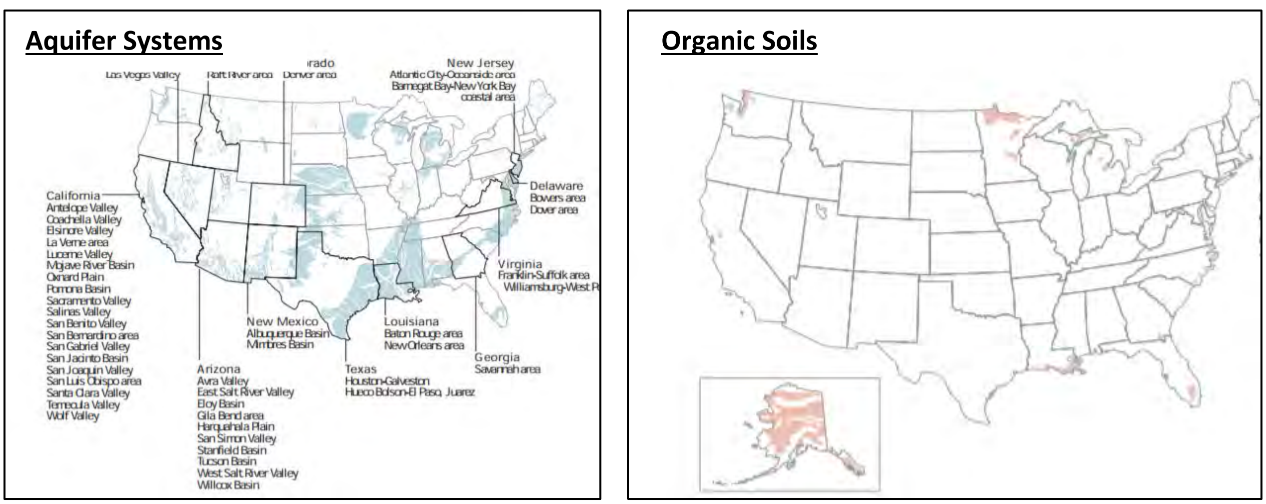
Description

Land subsidence is the gradual settling or sudden sinking of the earth's surface due to subsurface movement of earthen minerals, rocks, soil and water. The principal causes are identified as aquifer system compaction, drainage of organic soils, underground mining, hydrocompaction, natural compaction, sinkholes, and thawing permafrost. These causes are further defined by three distinct processes:

- Compaction of aquifer systems due to excessive groundwater pumping;
- Drainage and subsequent oxidation of organic soils; and
- Dissolution and collapse of susceptible rocks/subsurface cavities, or sinkholes.

Mining of ground water and drainage of organic soils are not applicable to the planning area. Figure 3.28 below presents the location of subsidence attributed to these two causes.

Figure 3.28. Subsidence Attributed to Compaction of Aquifer Systems and Organic Soils



Source: https://water.usgs.gov/ogw/pubs/fs00165/SubsidenceFS.v7.PDF

Sinkholes, however, are prevalent within the planning area. Certain areas underlain by limestone and dolomite in the planning area 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 channel ways, 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 series in Figure 3.29 – Figure 3.31.

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

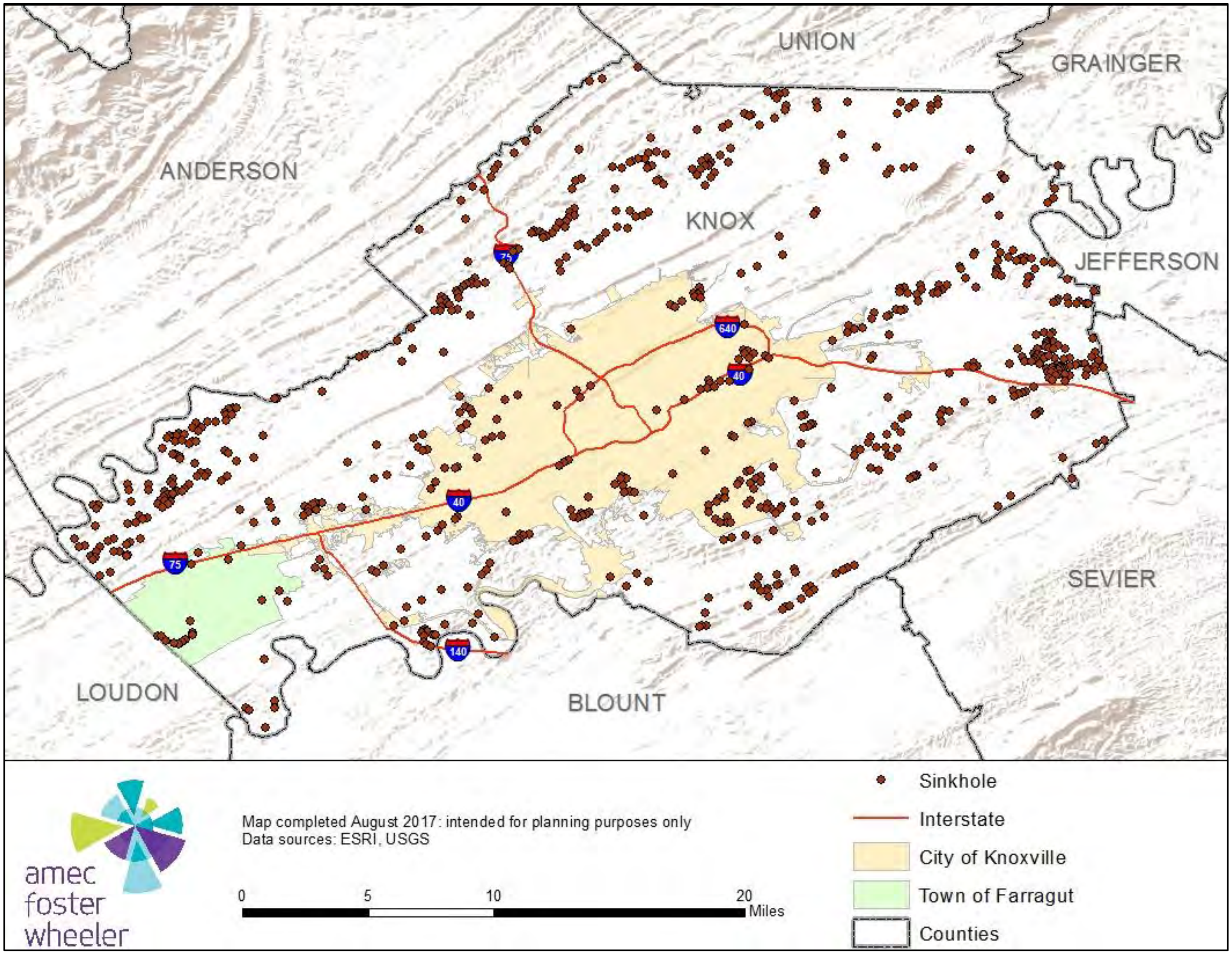


Figure 3.30. Areas with Abundant Sinkholes in City of Knoxville

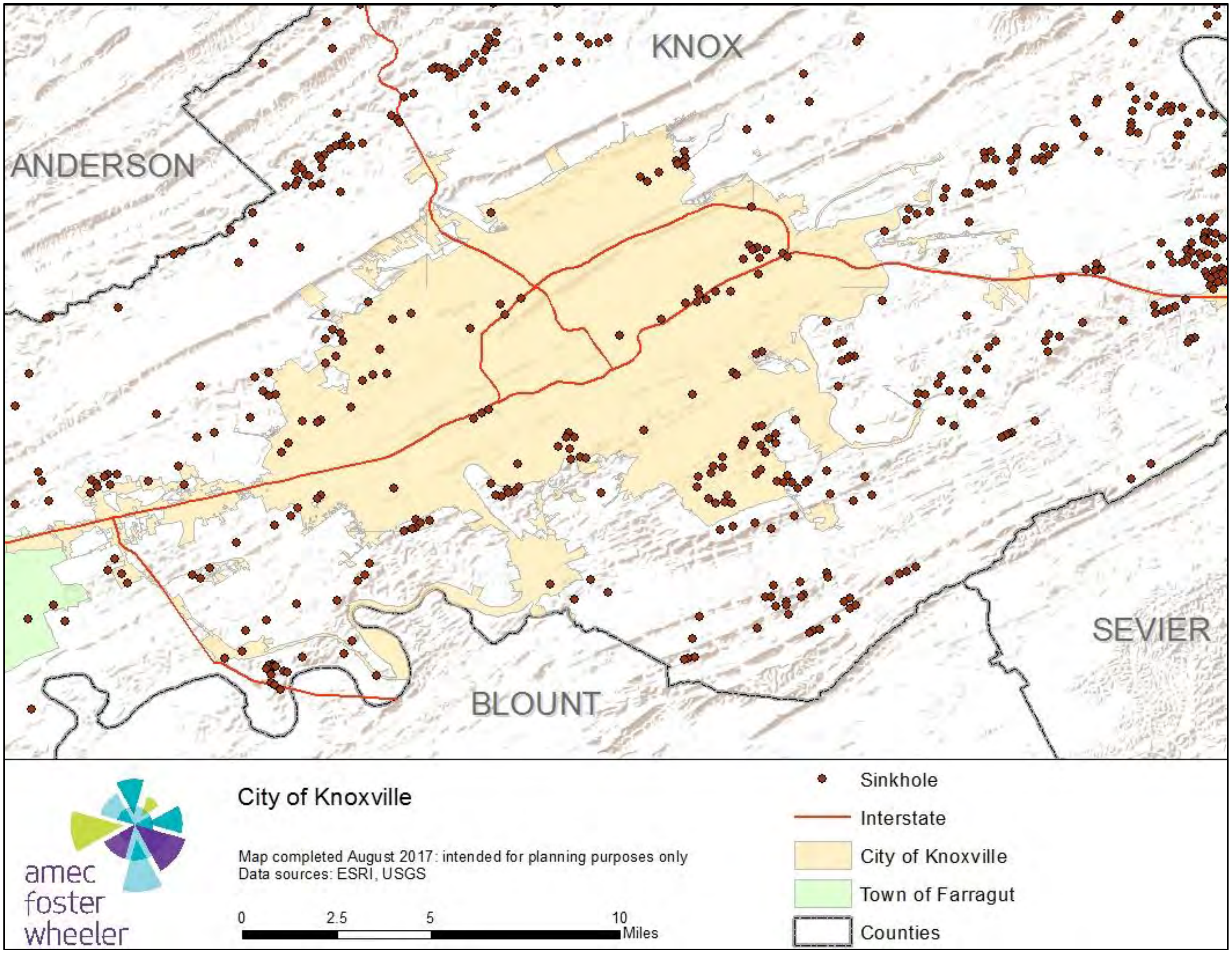
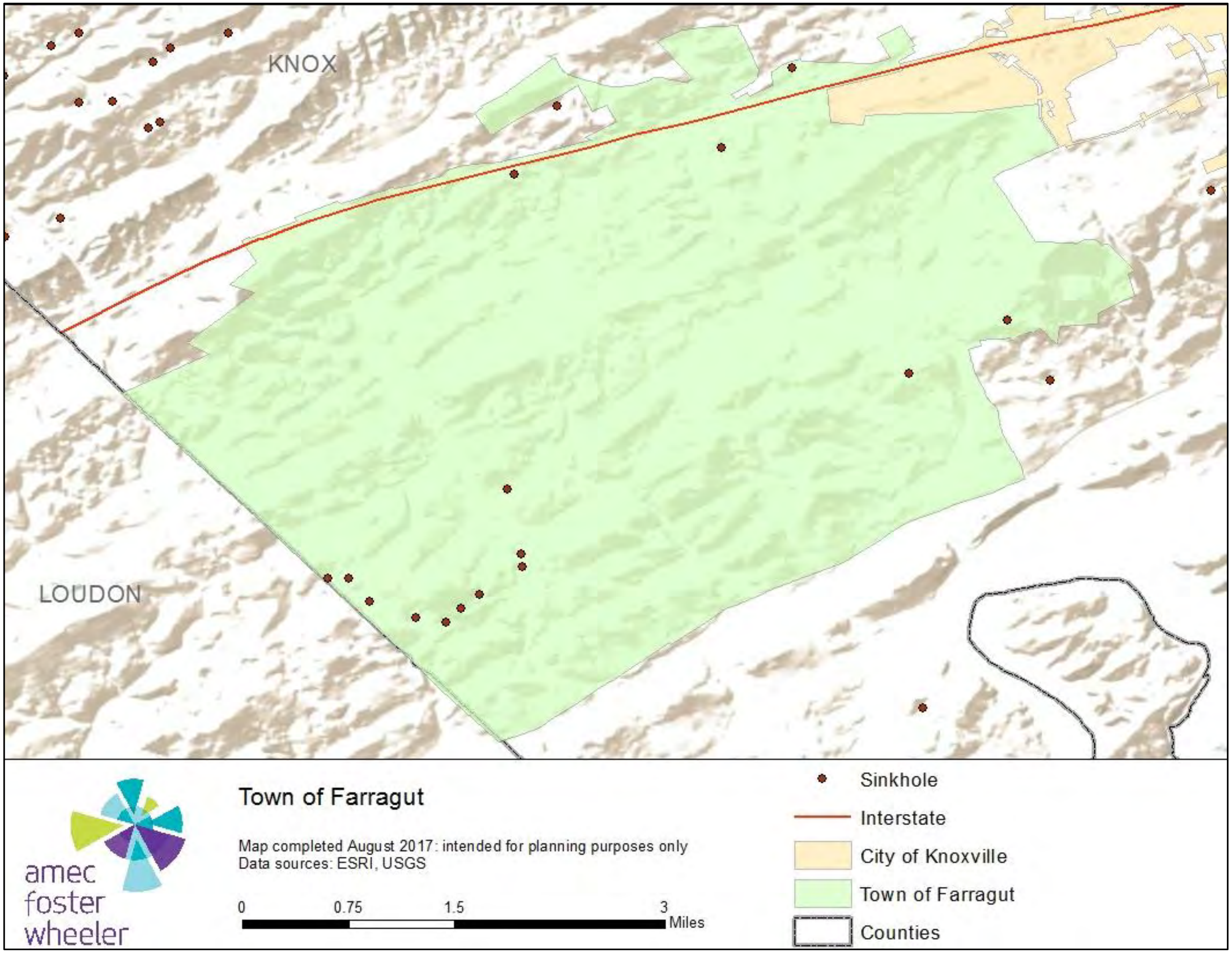


Figure 3.31. Areas with Abundant Sinkholes in Town of Farragut



Previous Occurrences

- **September 27, 2016—**A sinkhole closed lanes on Alcoa Highway in South Knoxville. All northbound lanes were closed and several southbound lanes. The sinkhole was 15 feet deep. The highway was not restored for several months due to the damage.
- **May 26, 2016—**A sinkhole opened near James White's Fort in historic downtown Knoxville. It only opened 18 inches, but officials believed it to be more than 50 feet deep.
- **December 26, 2015—**A sinkhole in West Knox County opened up on one family's property on Hickory Creek Road. It was 13 feet deep.
- **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 3.32. Sinkhole Collapse Adjacent to Chapman Highway, May 2005

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 2000-2017, there were six documented damaging sinkholes. This period of history results in a 35 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."

Changing Future Conditions

Changing in future conditions raise the likelihood of extreme weather, meaning the torrential rain and flooding conditions which often lead to the exposure of sinkholes are likely to become increasingly common. Certain events such as a heavy precipitation following a period of drought can trigger a sinkhole due to low levels of groundwater combined with a heavy influx of rain.

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. However, as demonstrated in the map in Figure 3.31, the Town of Farragut sinkholes have been identified within the jurisdictional boundaries.

	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	4-Highly Likely	2-Limited	2-Significant	2.9 (Medium)
Knox County (unincorporated)	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	4-Highly Likely	2-Limited	2-Significant	2.9 (Medium)
Knox County School District	4-Highly Likely	2-Limited	2-Significant	2.9 (Medium)

3.1.5 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.

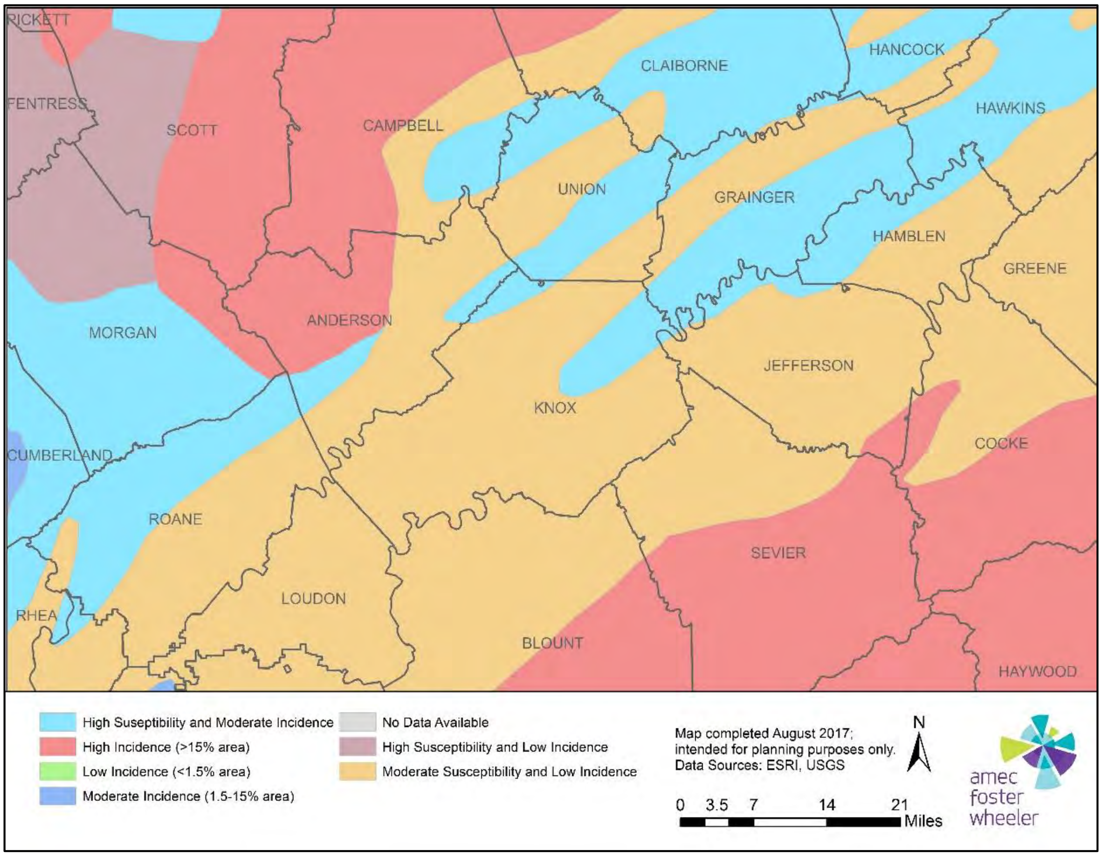
Landslides constitute a major geologic hazard because they are widespread, occur in all 50 states and U.S. territories, and cause $1-2 billion in damages and more than 25 fatalities on average each year. Expansion of urban and recreational developments into hillside areas leads to more people that are 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 the planning area 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 3.33 shows areas of landslides and areas susceptible to future landslides in the planning area. As this map demonstrates, all of the planning area has at least moderate susceptibility but low incidence of landslide. 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.

Figure 3.33. Landslide Incidence and Susceptibility



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 3.34, 3.35, and 3.36 provides the soil slippage potential map for the planning area.

Figure 3.34. Soil Slippage Potential Knox County

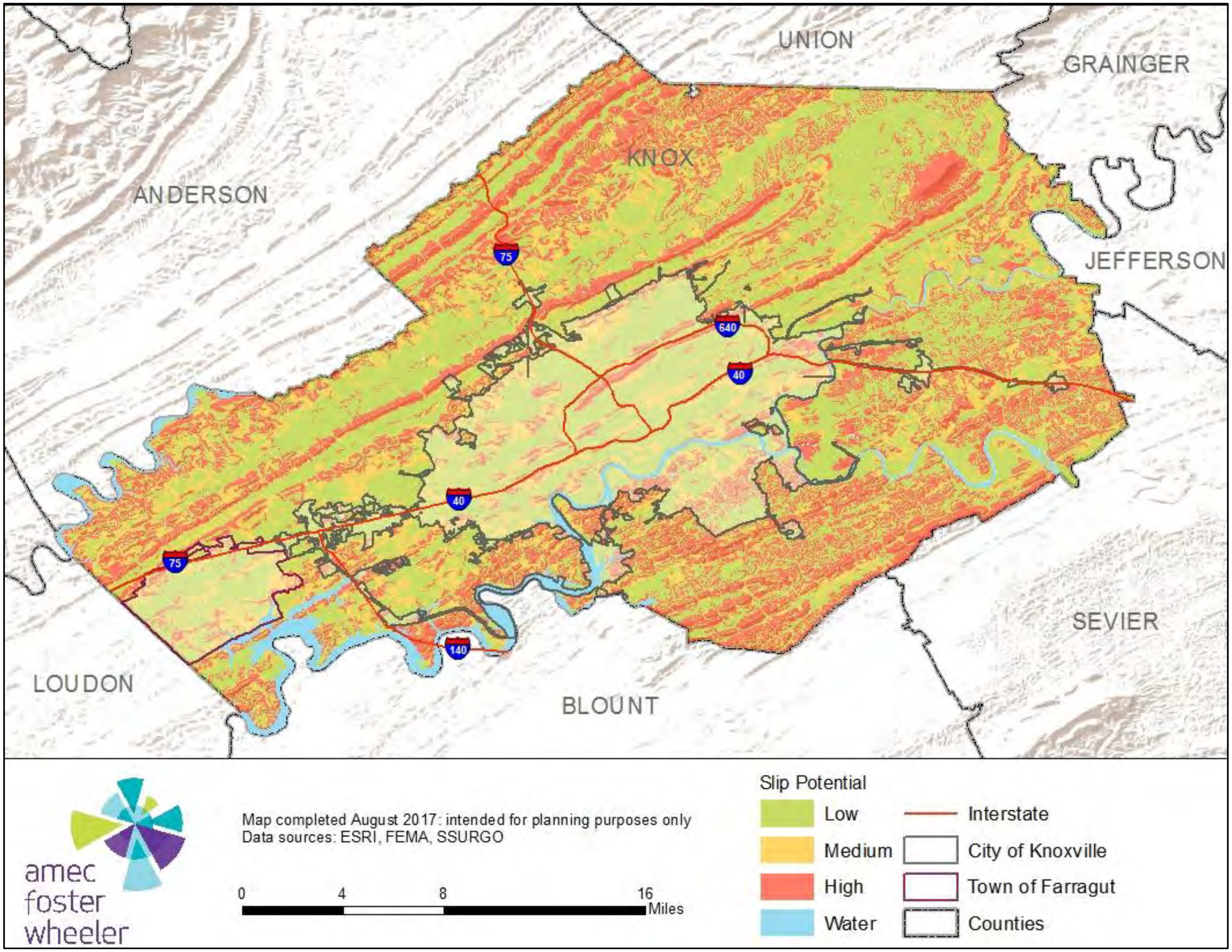


Figure 3.35. Soil Slippage Potential in City of Knoxville

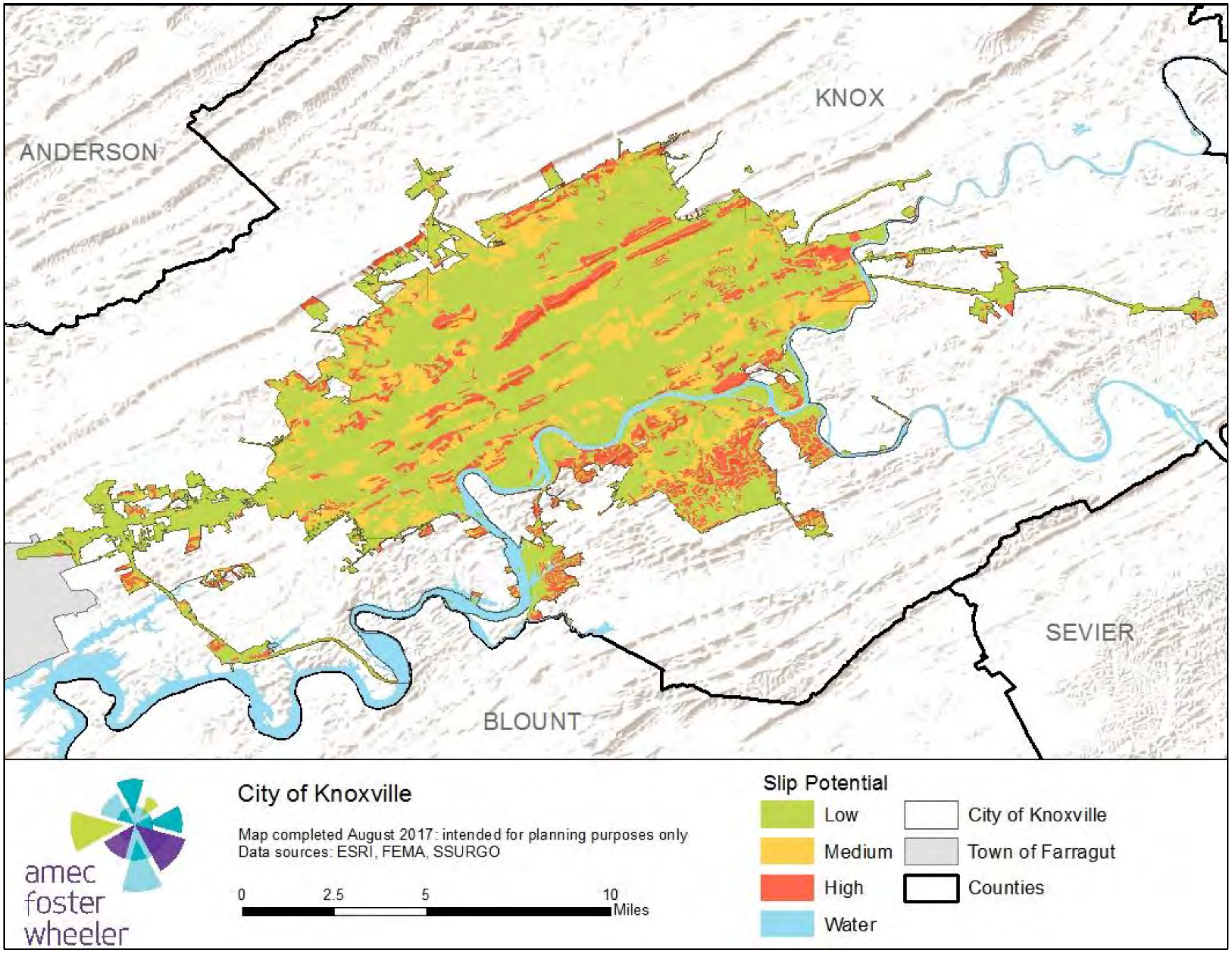


Figure 3.36. Soil Slippage Potential in Town of Farragut

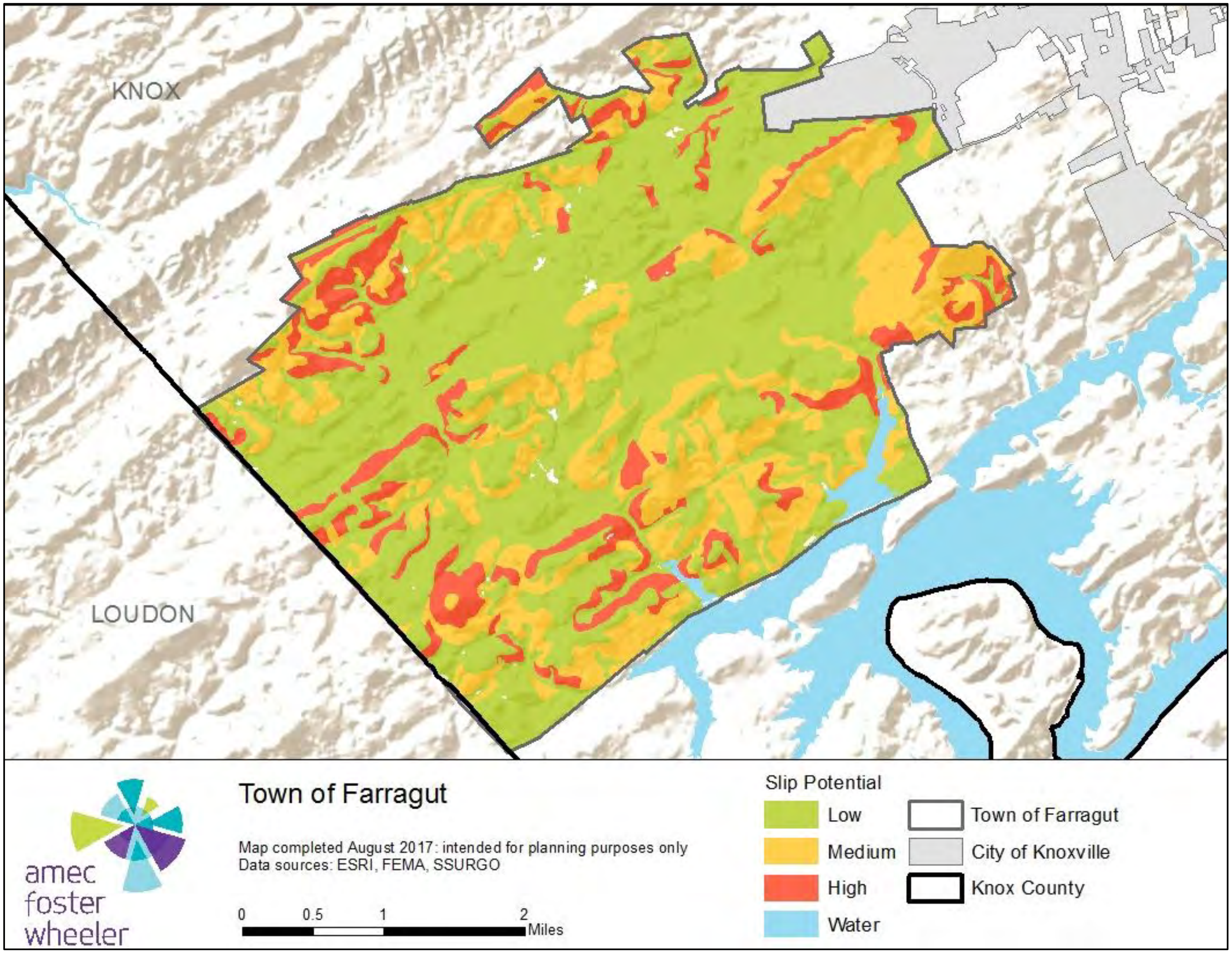


Table 3.20 Slip Potential and Slope Gradient of Land in City of Knoxville

Soil Slip Potential	Sq. Miles
Low	85.448
Medium	18.432
High	15.684
Slope Gradient (percent)	**Sq. Miles**
0.00 – 5.0	29.655
5.01 – 11	71.296
11.01 – 25	19.729
25.01 – 40	8.552
40.01 – 70	5.299

Table 3.21 Slip Potential and Slope Gradient of Land in Town of Farragut

Soil Slip Potential	Sq. Miles
Low	10.435
Medium	4.389
High	1.974
Slope Gradient (percent)	**Sq. Miles**
0.00 – 5.0	4.193
5.01 – 11	6.745
11.01 – 25	4.483
25.01 – 40	1.867
40.01 – 70	0.014

Generally, slopes are measured as a percentage or as a ratio (rise/run). The terms slope and grade are often used interchangeably. Table 3.22 provides slope characteristics of land in Knox County and Figure 3.37, Figure 3.38, and Figure 3.39 provides a map of the planning area with slope classifications.

Table 3.22 Slope Characteristics of Land 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 3.37. Slope Classifications in Knox County

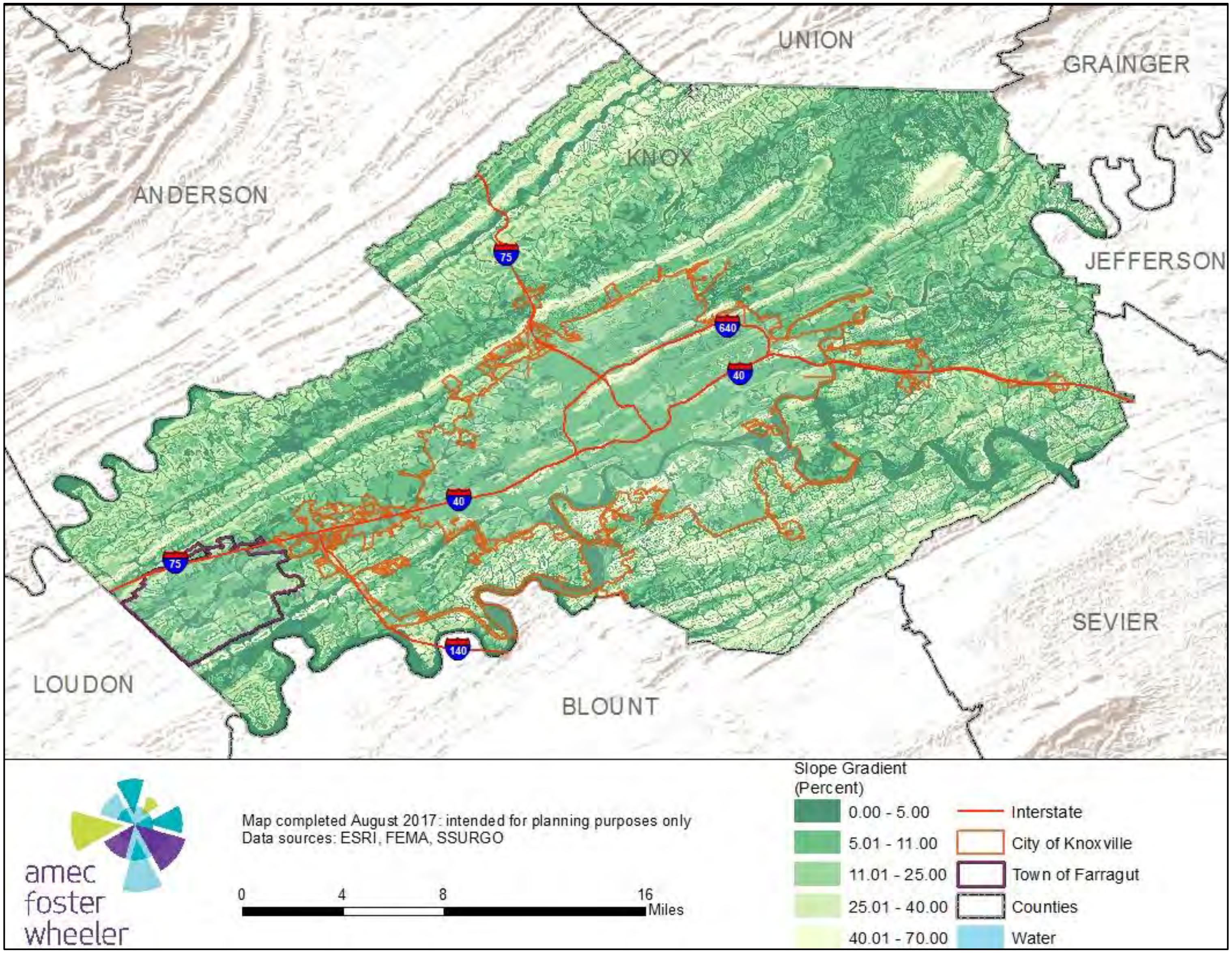


Figure 3.38. Slope Classifications in City of Knoxville

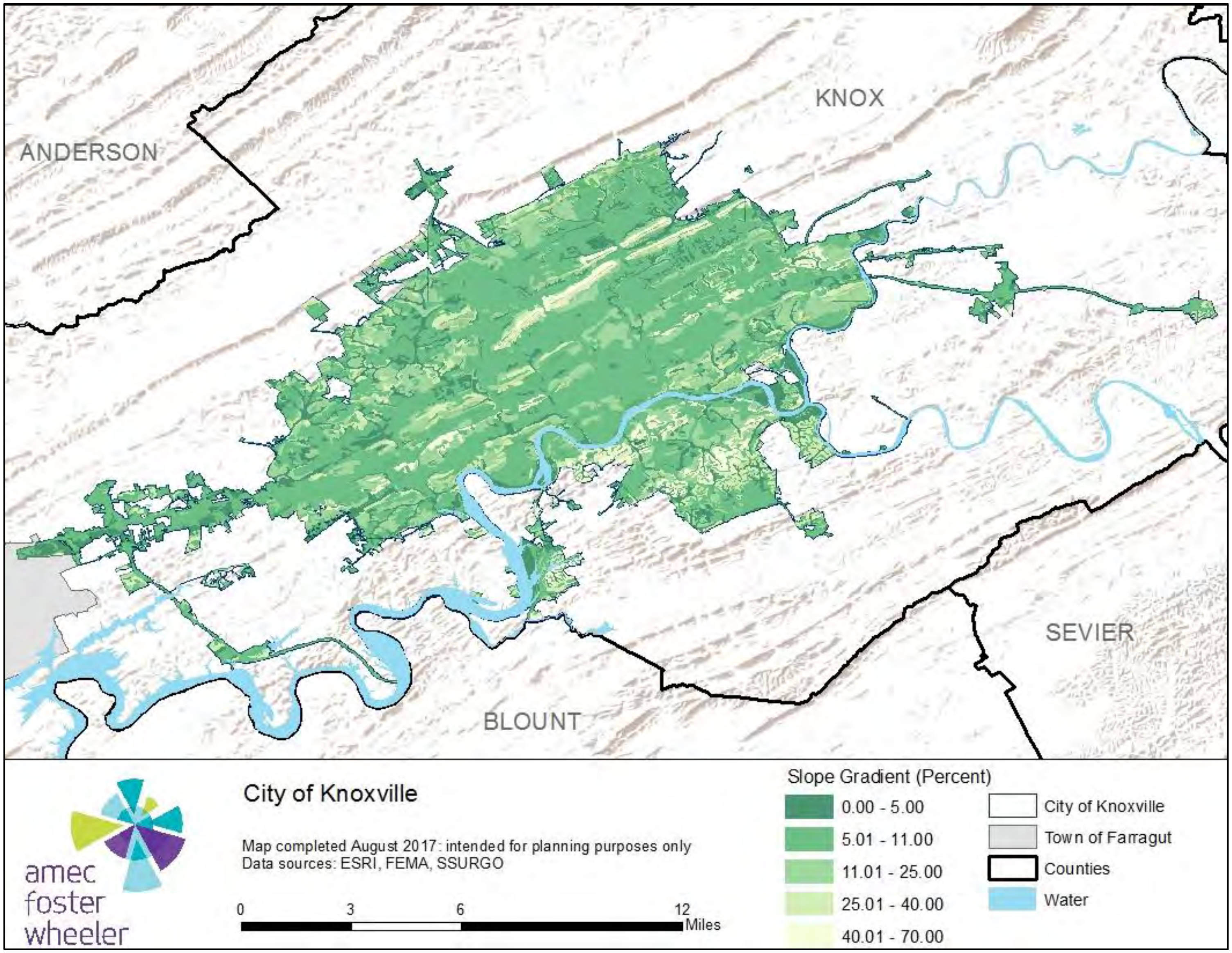
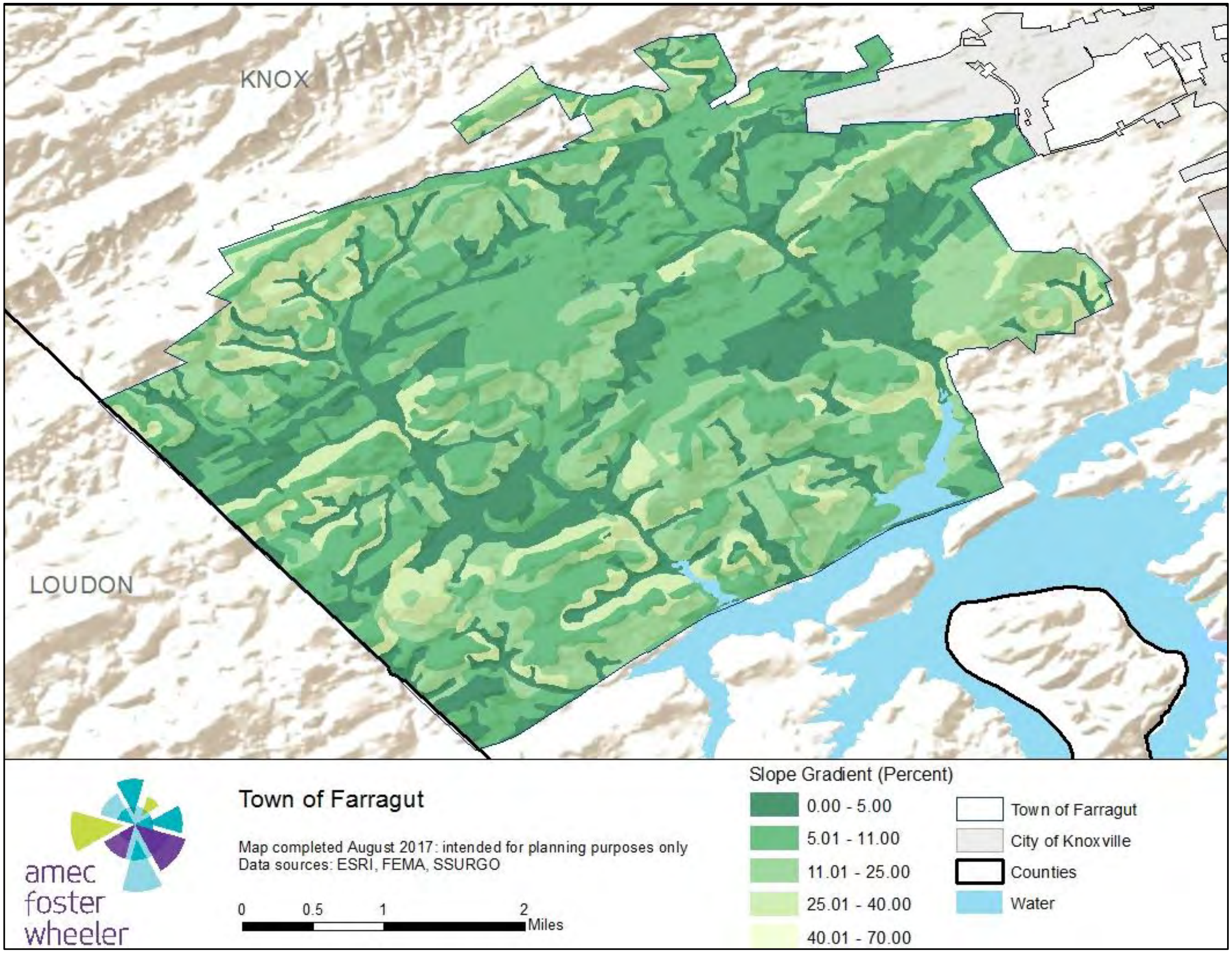


Figure 3.39. Slope Classifications in Town of Farragut



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 3.409 and Figure 3.41 show the landslide from the up-slope and down-slope views respectively.

Figure 3.40. 2003 Forest Ridge Apartments Landslide

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

Figure 3.41. 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 2000-2017. This suggests a 12 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."

Changing Future Conditions

Future conditions expect an increase in heavy rainfall which can lead to more erosion and landslides. The expansion of urban and recreational developments into hillside also puts more people at risk of landslides. Since landslides commonly occur along with other natural disasters like floods, there is a possibility of more landslides due to the increasing threat of flooding.

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 (unincorporated)	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)
Knox County School District	3-LIkely	2-Limited	2-Significant	2.45 (Medium)

3.2.8 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 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 3.23 describes typical damage impacts of the various sizes of hail.

Table 3.23 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 3.44 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 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

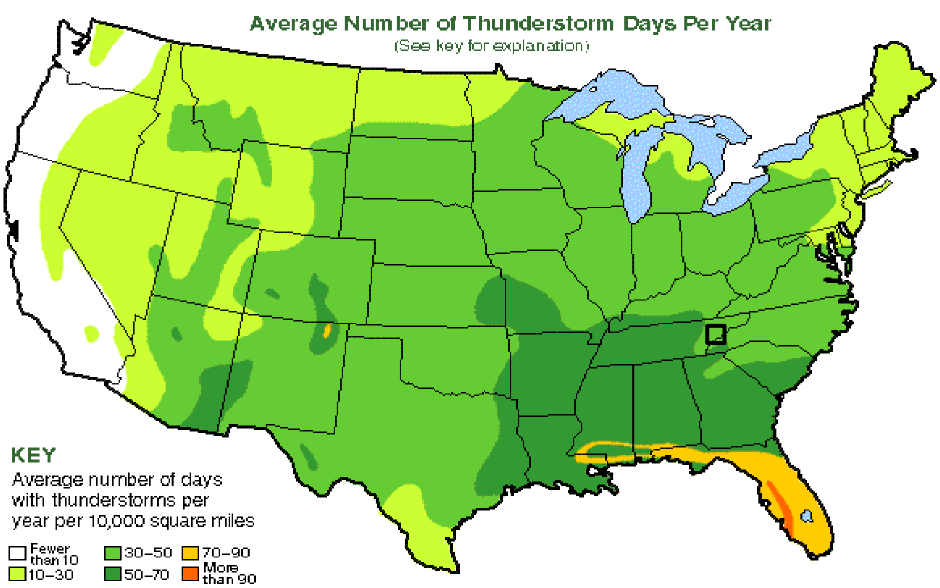
Lightning is defined as any and all of the various forms of visible electrical discharge caused by thunderstorms. Lightning can occur from cloud-to-cloud, within a cloud, cloud-to-ground, or cloud-to-air. It causes an average of about 60 fatalities and 300 injuries each year when people are caught outdoors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

Figure 3.42 and Figure 3.43 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 3.42. 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 3.43. Average Number of Thunderstorm Days Per Year



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

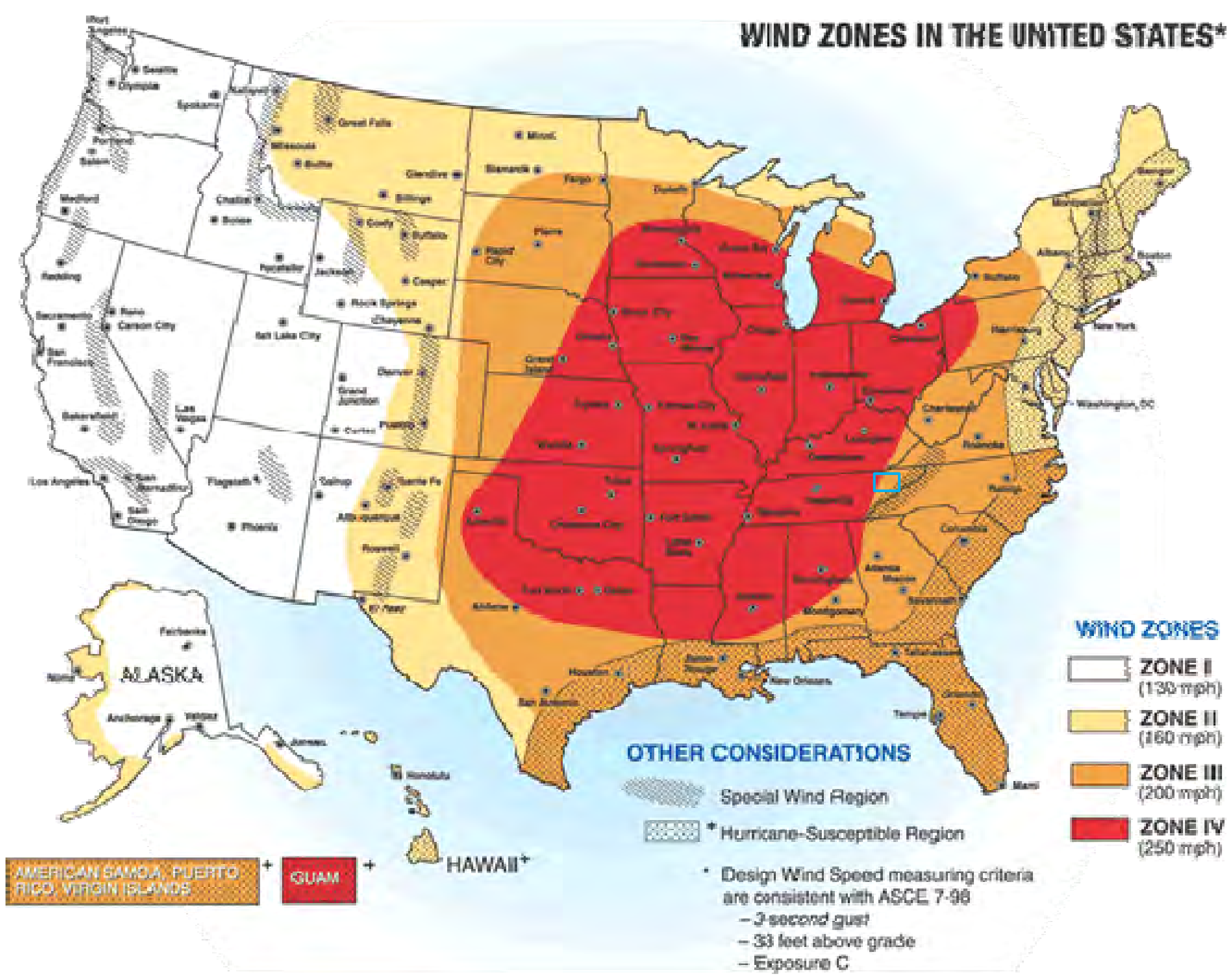
Geographic Location

Thunderstorms and the associated hail, high wind, and lightning impact the entire 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 the planning area is susceptible to high wind events, and all of the participating jurisdictions are vulnerable to this hazard. Figure 3.43 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 3.44. 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 eight declarations that Knox County received including severe storms are summarized below in Table 3.24. These events are also discussed separately in the flood and tornado profiles.

Table 3.24 Thunder Storm Disaster Declaration History in Knox County, 1965-Present

Declaration Number	Declaration Date (incident period)	Disaster Description
4320	6/23/2017 (5/27-28/2017)	Severe Storms, Straight-line Winds, Flooding
4211	4/2/2015 (2/15-23/2015)	Severe Winter Storm and Flooding
4005	7/20/2011 (6/18-24/2011)	Severe Storms, Straight-line Winds, Tornadoes, Flooding
1974	5/1/2011 (4/25-28/2011)	Severe Storms, Tornadoes, Straight-line Winds, Associated Flooding
1464	5/8/2003 (5/4-30/2003)	Severe Storms, Tornadoes, and Flooding
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 128 hail events in the planning area between 1962 and July 2017. 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 28 events in the same 55-year period causing a reported $51,300 in property damage. Table 3.25 shows the number of hail events by the size of the hail.

Table 3.25 Knox County Hail Events Summarized by Hail Size from 1962 to July 2017

Hail Size	Number of Events	Property Damages
< 0.88 in	37	$200
0.88 in.	9	0
1.00 in.	50	$6,000
1.25 in.	3	$5,000
1.50 in.	6	0
1.75 in.	16	$10,100
2.00 in.	3	0
2.50 in.	1	0
2.75 in.	2	$30,000
3.00 in.	1	0
Total	128	$51,300

Source National Climatic Data Center Storm Events Database

Figure 3.45. 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

According to the USDA's Risk Management Agency, insured crop losses in Knox County as a result of hail from 2007 to 2016 totaled $874 due to a hazard event in 2011.

High Winds

According to the NCDC database, newspaper articles from the *Knoxville New Sentinel* and the *Knoxville Journal*, the planning area experienced 252 severe thunderstorms with high winds in excess of 58 miles per hour (50 knots) from 1950 to July 2017. Descriptions of the events are only provided from 1993 to 2017 and during this 24-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:

- **December 14, 2015**—A storm with very high winds exceeding 50 knots moved through Knox County on this day.
- **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 2007 through 2016, insurance payments for damages to crops occurred in 2011 totaled $874. Also state-wide in Tennessee, 83 percent of the row crops were insured in 2017 according to the USDA Risk Management Agency.

Lightning

From 1995 to 2017, 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 252 wind events in the planning area between 1950 and 2017 (67 years). Based on this information, the probability that at least one significant wind event with 50 knots or higher will occur in the planning area in any given year is “highly likely” with an annual average of 4.18 events per year.

Based on the reported 28 events in the NCDC database of hail events with hail 1.75 inches in diameter and larger occur an average of .5 times per year in the planning area from 1962 to 2017.

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 from 1990 - 2017 were reported to be $2.897 Million in property damages and $257,000 in crop damage. 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”.

Changing Future Conditions

Hail Future atmospheric conditions are predicted to have more CAPE and a decrease in wind shear. CAPE or Convective Available Potential Energy is the energy available for convection which is used for updraft in a severe storm. Wind shear is a sudden change in wind speed and/or direction and what tilts the updraft in a severe storm creating favorable conditions for hail or a tornado. An increase in CAPE and decrease in wind shear are not favorable environments for hail. It may appear to be an increase in hail events or increase in damage caused by hail over the last decade but there is a bias since reporting and data collection for hail data began in 1950. Also, an increase in population and people’s ability to report severe weather events have made it easier for hail events and other sever storm events to be reported.

High winds Wind speeds have increased globally over the past 20 years; however, it is not clear whether it is due to climate change or if it’s part of a cyclical pattern.

Lightning With atmospheric conditions favoring more CAPE there is a possibility for more storms. However, there it is still debate about whether there will be an increase or decrease with most research favoring an increase in CAPE and precipitation resulting in more lightning events. Most possible impacts are focused around forest fire implications.

Severe Storms Hazard Summary

	Probability	Magnitude	Spatial Extent	Ranking
Overall Planning Area	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)
Knox County School District	4-Highly Likely	2-Limited	3 Extensive	3.1 (High)

3.2.9 Tornadoes

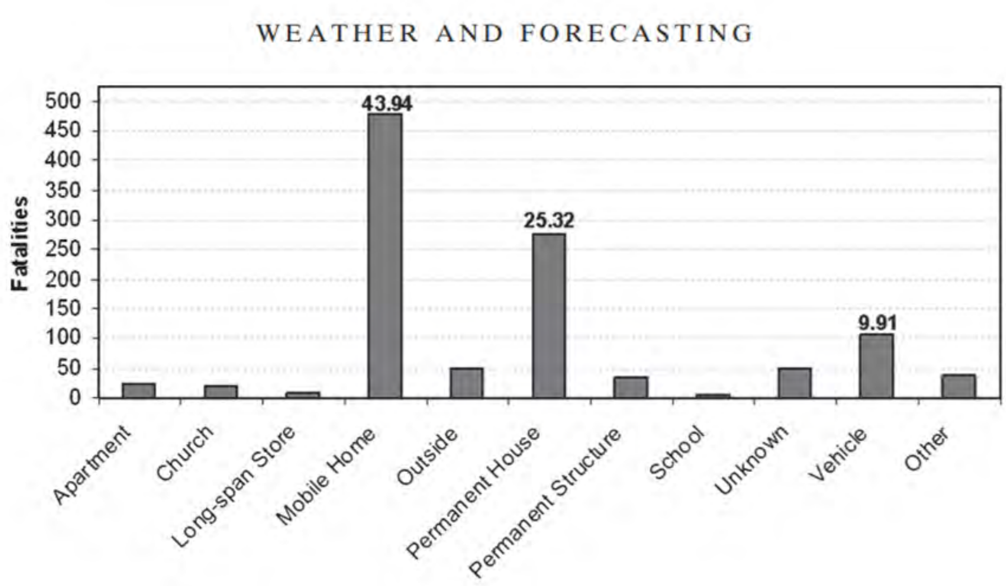
Description

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.

Tornado fatalities are unique compared to other natural hazards since most tornadoes fatalities occur within housing structures since people are more likely to seek shelter in tornadic events. Certain buildings that are used for shelter can increase or decrease one's vulnerability to tornadoes. Figure 3.46 indicates tornado fatalities by location of where the fatality occurred from 1985 – 2007 . Mobile homes have the highest number of fatalities compared to all other shelters. Therefore, mobile homes should not be used as shelter in the event of a tornado, so if possible before a tornado strikes, find shelter in a nearby building with a basement.

Figure 3.46. Tornado fatalities by location of where the fatality occurred, 1985 - 2005



Source: Ashley, Walker S., et al. "Spatial Temporal Analysis of Tornado Fatalities in United States: 1880 - 205." *Weather and Forecasting:* Vol 22, No 6. Accessed September 21, 2017. http://journals.ametsoc.org/doi/abs/10.1175/2007WAF2007004.1.

Although Tennessee does not experience the highest number of tornado events and is not located within common tornadic-prone areas like Tornado Alley, the state still has a high number of fatalities. The reasons for more tornado fatalities in Tennessee is due to a combination of high percentage of nocturnal tornadoes, high percentage of mobile homes which are not suitable to take shelter in during a tornado, and high percentage of forest cover which decreases visibility of tornadoes.

Therefore, understanding the difference between tornado watches and warnings is essential to tornado vulnerability. According to National Weather Service, a tornado watch means that the weather conditions favor thunderstorms that are capable of producing tornadoes. A tornado warning is issued by your local forecast office and means that a tornado is occurring or will shortly in the area for the warning.

- Tornado Watch: Be Prepared! Tornadoes are possible in and near the watch area. Review and discuss your emergency plans and check supplies and your safe room. Be ready to act quickly if a warning is issued or you suspect a tornado is approaching.
- Tornado Warning: Take Action! A tornado has been sighted or indicated by weather radar. There is imminent danger to life and property. Move to an interior room on the lowest floor of a sturdy building. Avoid windows. If in a mobile home, a vehicle, or outdoors, move to the closest substantial shelter and protect yourself from flying debris.

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

Table 3.26 Original Fujita Scale

Fujita (F)	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 3.27 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 3.27 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

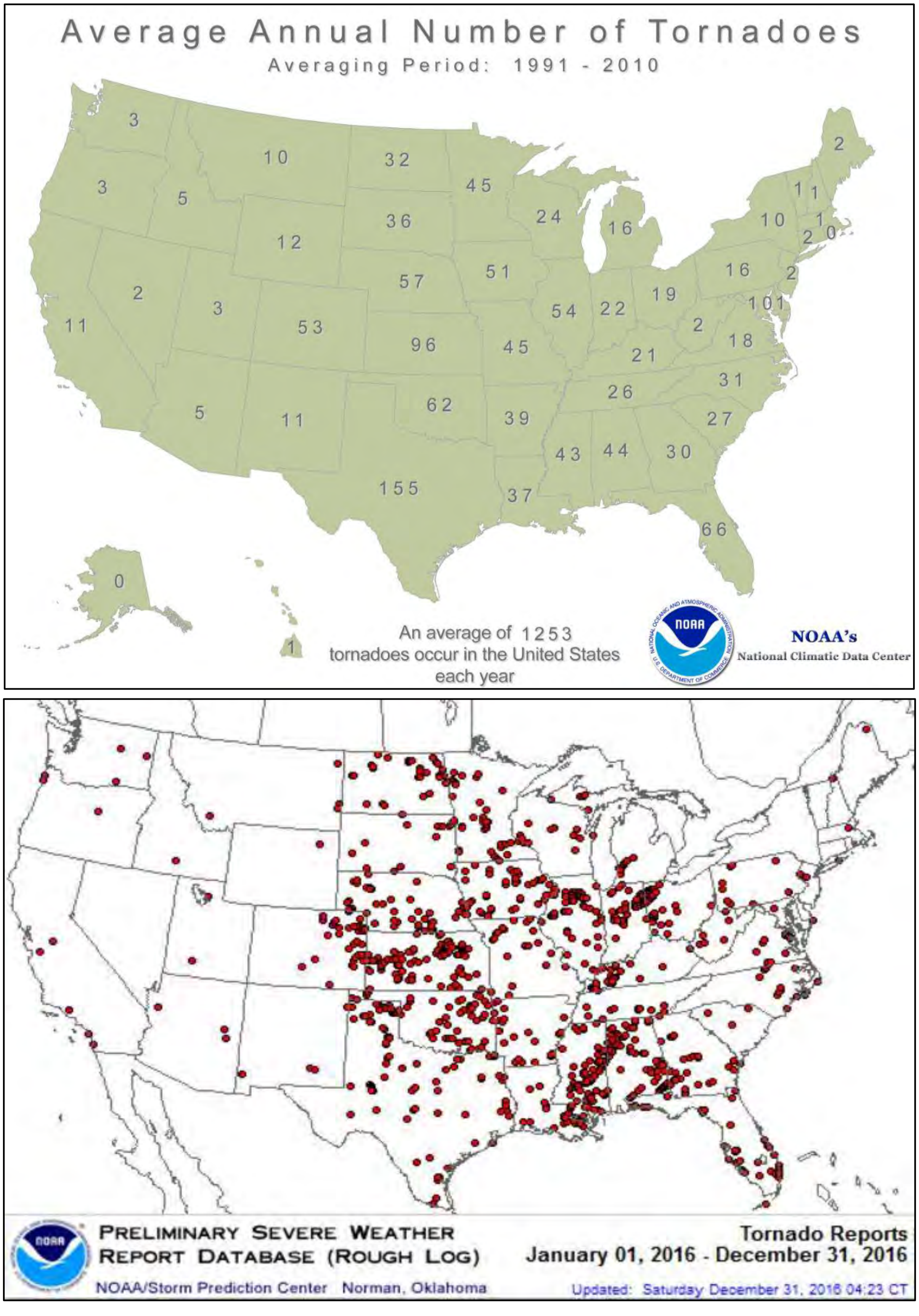
Source: National Oceanic and Atmospheric Administration Storm Prediction Center, www.spc.noaa.gov/faq/tornado/ef-scale.html

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. Figure 3.47 illustrates the average number of F3, F4, and F5 tornadoes recorded in the United States per state between 1991-2010, as well as a map showing the locations of tornado reports in 2016. The ridges and valleys characteristic of East Tennessee minimize the risk from tornadoes in the planning area.

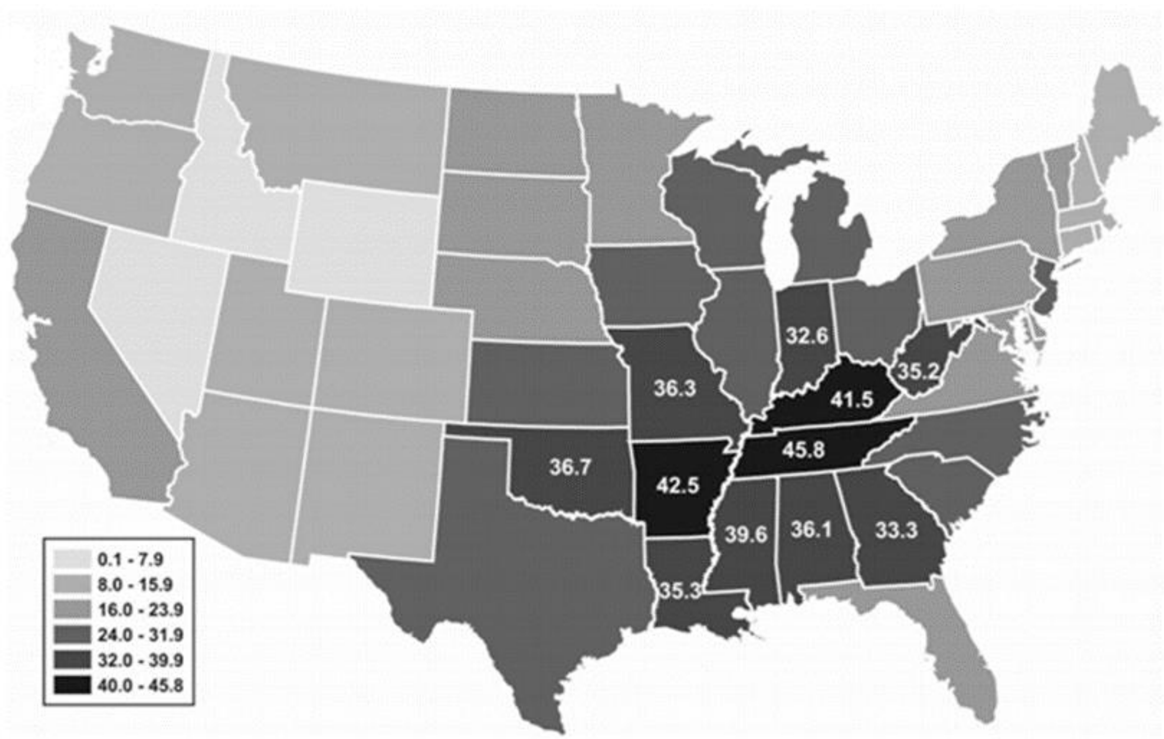
The planning area is not located within the boundaries of "Tornado Alley", which is an area in the United States that receives more tornadoes than anywhere else besides Florida. Tornadoes within “Tornado Alley” can reach Category EF3 and above on the Enhanced Fujita Scale, which are considered to be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

Figure 3.47. Tornado Activity in the United States, 1991-2010 and 2016



Almost half of the tornado events that occur in Tennessee, occur at night. Tennessee has the highest percent of nocturnal tornado events compared to all other states with 45.8% of all tornado events occurring at night as shown in Figure 3.48. Tennessee also ranked second in the greatest percentage of killer nocturnal tornado events from 1950 to 2005 (Ashley et al. 2008). Areas in the South for example the Tennessee River valleys, have the highest percentages of nocturnal tornadoes, nocturnal fatalities, and number of nocturnal killer events compared to other regions in the United States (Ashley et al. 2008).

Figure 3.48. Percent of Tornadoes Events that Occur at Night



Source: Ashley, Walker S., et al. "Vulnerability due to Nocturnal Tornadoes." *Weather and Forecasting,* vol. 23, no. 5, 2008, pp. 795 – 807., doi: 10.1175/2008waf2222132.1.

Previous Occurrences

According to the NCDC database, there were fifteen separate tornado events in Knox County between 1950 and July 2017 (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, seven were rated F0, five were rated F1, two were rated F2, one was rated F3. Table 3.28 summarizes these events.

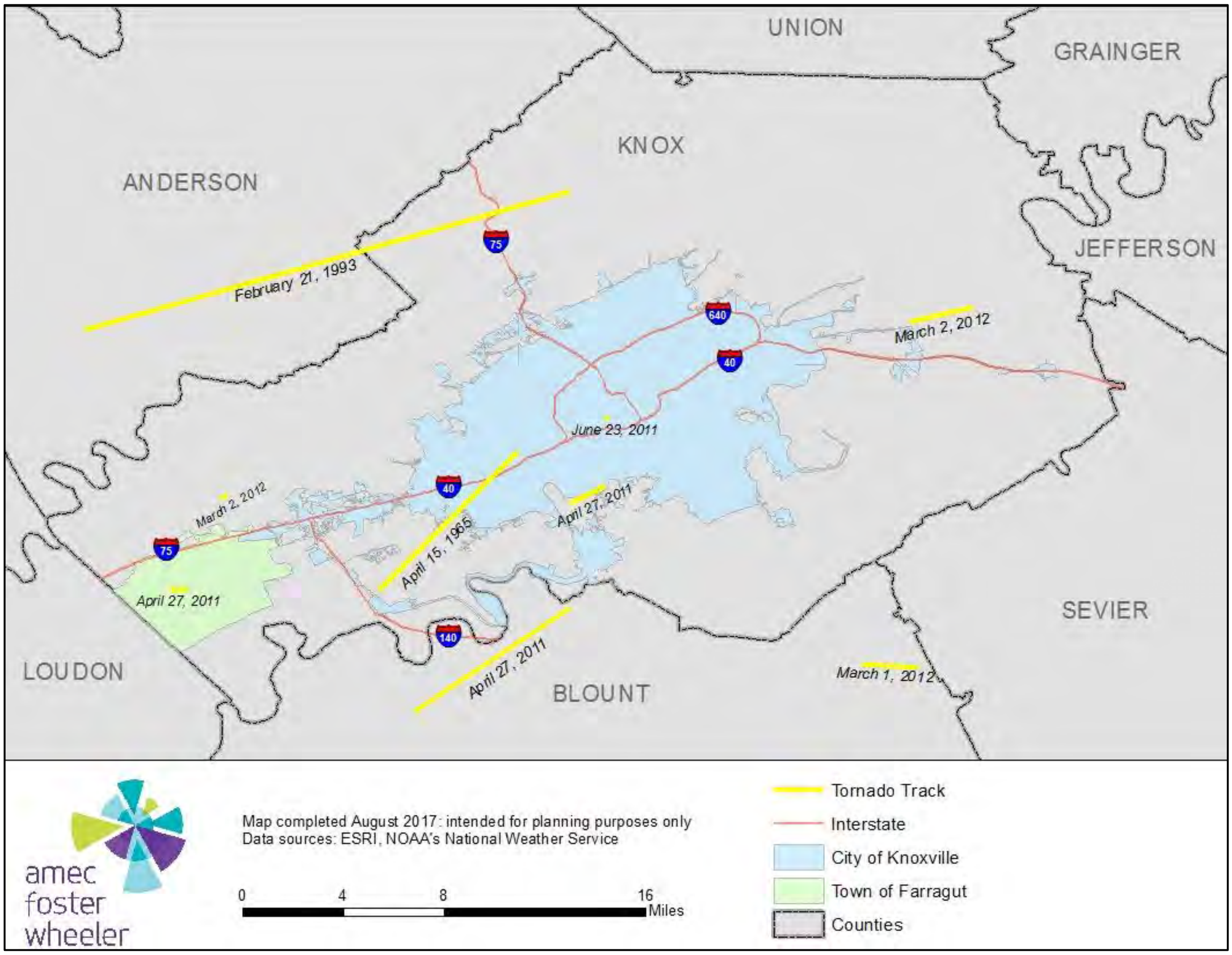
Knox County has been included in three presidential disaster declarations that involved tornadoes since 1955 (see details below under DR-1464, DR-1331, and DR-424).

Table 3.28 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
April 27, 2011	6:57 PM	0	0	1	F1	Near Kingsley Station	$20,000
April 27, 2011	8:28 PM	0	0	1	F0	Farragut	$10,000
June 23, 2011	11:20 PM	0	0	1	F0	Malcolm Martin Park	$40,000
March 2, 2012	8:33 PM	0	0	0.3	F0	Turkey Creek	$1,000
March 2, 2012	9:00 PM	0	0	2.1	F0	Trentville	$20,000
Total		**2**	**31**				**$7.99 M**

Source: National Climatic Data Center

Figure 3.49. Tracks of Tornadoes in Knox County from 1953 – 2012.



Descriptions of the more damaging events are provided below:

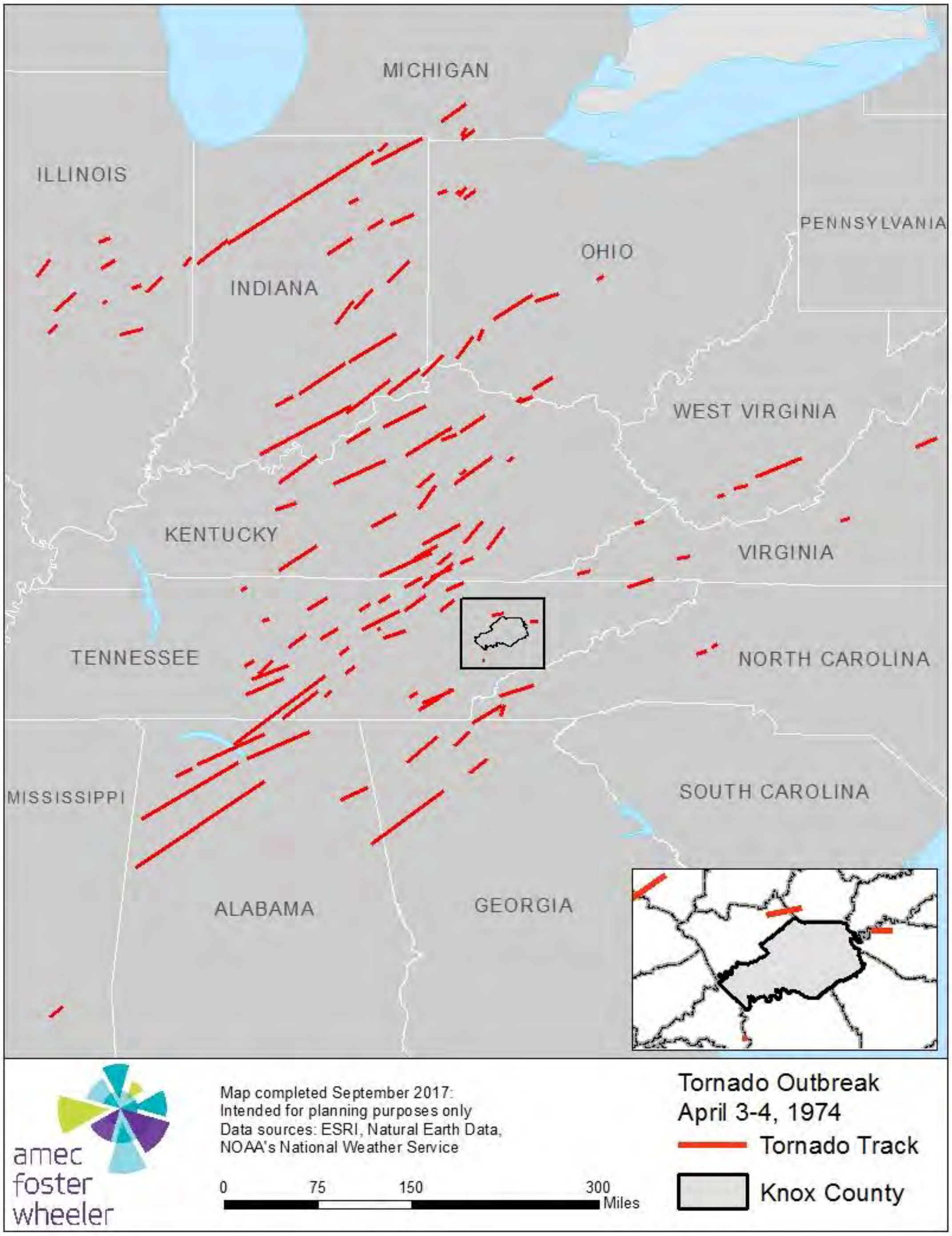
- **May 8, 2003-FEMA-1464-DR (period of incident May 4-30, 2003)**—This federal disaster declaration was made following severe storms, tornadoes, and flooding in Tennessee. This federal declaration mainly stems from a tornado outbreak in western and northwestern Tennessee on May 4, 2003. Knox County 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.

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



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 the planning area 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 minimized 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”.

Changing Future Conditions

Current research suggests an increase in more tornadoes outbreaks due to changing heat and moisture content in the atmosphere brought on by increasing average temperatures. The number of days with large outbreaks has been increasing since the 1950s, but areas that normally see tornado activity are not expanding. Therefore, it should be expected to see more tornadoes on fewer days in areas that already experience tornadoes.

Tornadoes Hazard Summary

	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	3-LIkely	2-Limited	1-Limited	2.25 (Medium)
Knox County (unincorporated)	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)
Knox County School District	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 the planning areas 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.

Wildland-urban interface (WUI) refers to an area where homes and communities are built near or among lands prone to wildfires. The WUI is not exactly a place but a set of conditions that exist in every community. According to the National Fire Protection Association, conditions include (but are not limited to): the amount, type, and distribution of vegetation; the flammability of the structures (homes, businesses, outbuildings, decks, fences) in the area, and their proximity to fire-prone vegetation and to other combustible structures; weather patterns and general climate conditions; topography; hydrology; average lot size; and road construction. The wildland-urban intermix is a type of wildland-urban interface where homes and /other structures are intermixed within wildland fuels. These areas are more vulnerable to wildfires because the human development is intermixed with wildfire fuel.

According to the USDA Forest Service, as of 2010 the wildland-urban interface (WUI) of the conterminous United States includes about 44 million houses, which is equivalent to one in every three houses in the country. In the state of Tennessee approximately 38% of the all houses are located in wildland-urban interface. There has been a steady increase in areas that are a part of the wildland-urban interface due to the shift in decentralized urbanization and rapid development in outlying metropolitan areas. The expansion of WUI continues to increase the likelihood that wildfires will threaten structures and people.

Table 3.29 Wildland-Urban Interface and Intermix

City of Knoxville		
WUI	**Acres**	**Percent of Total Area**
High, Medium, Low Density Interface	4031.36	6.39%
High, Medium, Low Density Intermix	3711.36	5.89%
Town of Farragut		
WUI	**Acres**	**Percent of Total Area**
High, Medium, Low Density Interface	0.0000	0%
High, Medium, Low Density Intermix	293.76	2.86%
Unincorporated Knox County		
WUI	**Acres**	**Percent of Total Area**
High, Medium, Low Density Interface	52,090.05	16.01%
High, Medium, Low Density Intermix	127,989.44	39.35%

Figure 3.51 Wildland-Urban Interface (WUI) for Knox County

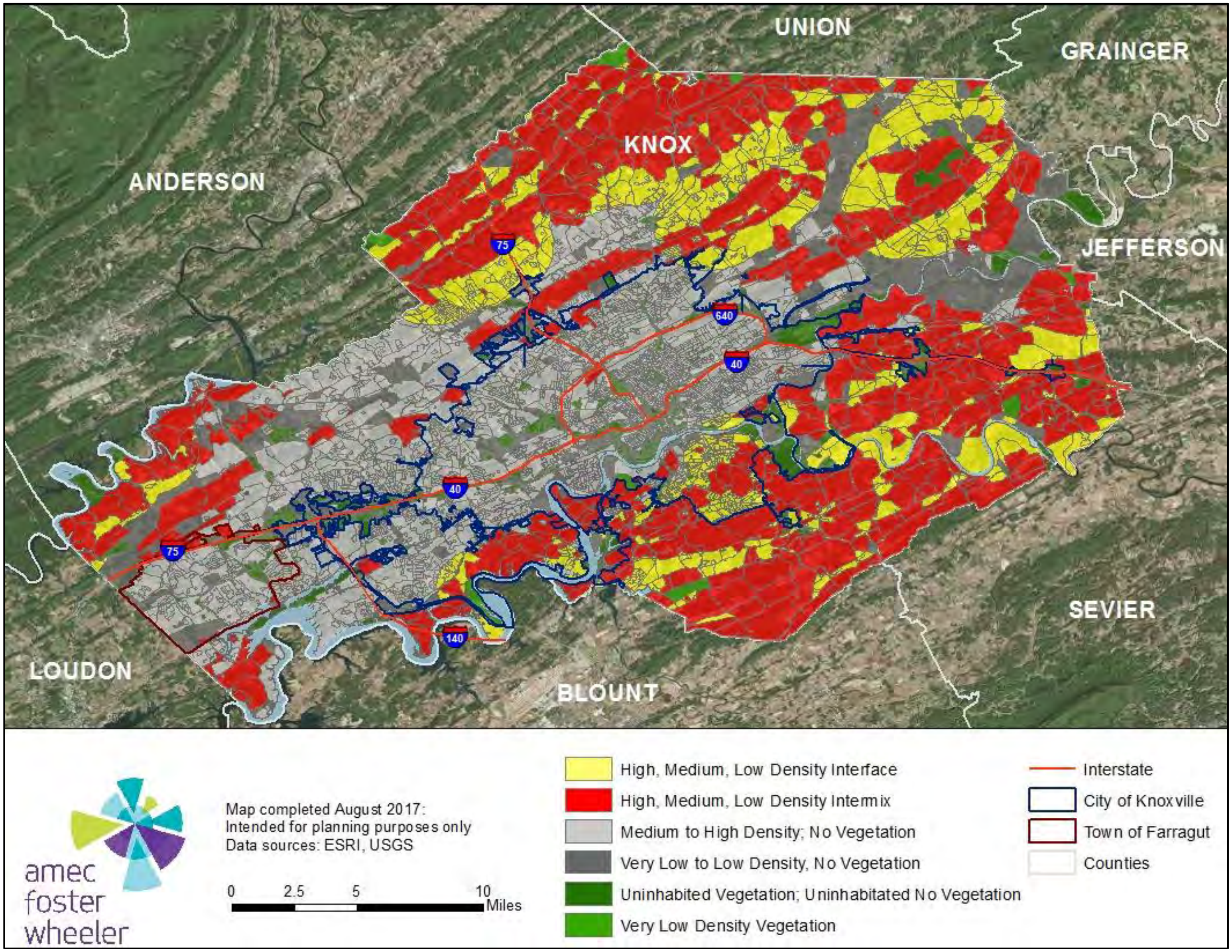


Figure 3.52 Wildland-Urban Interface (WUI) for City of Knoxville

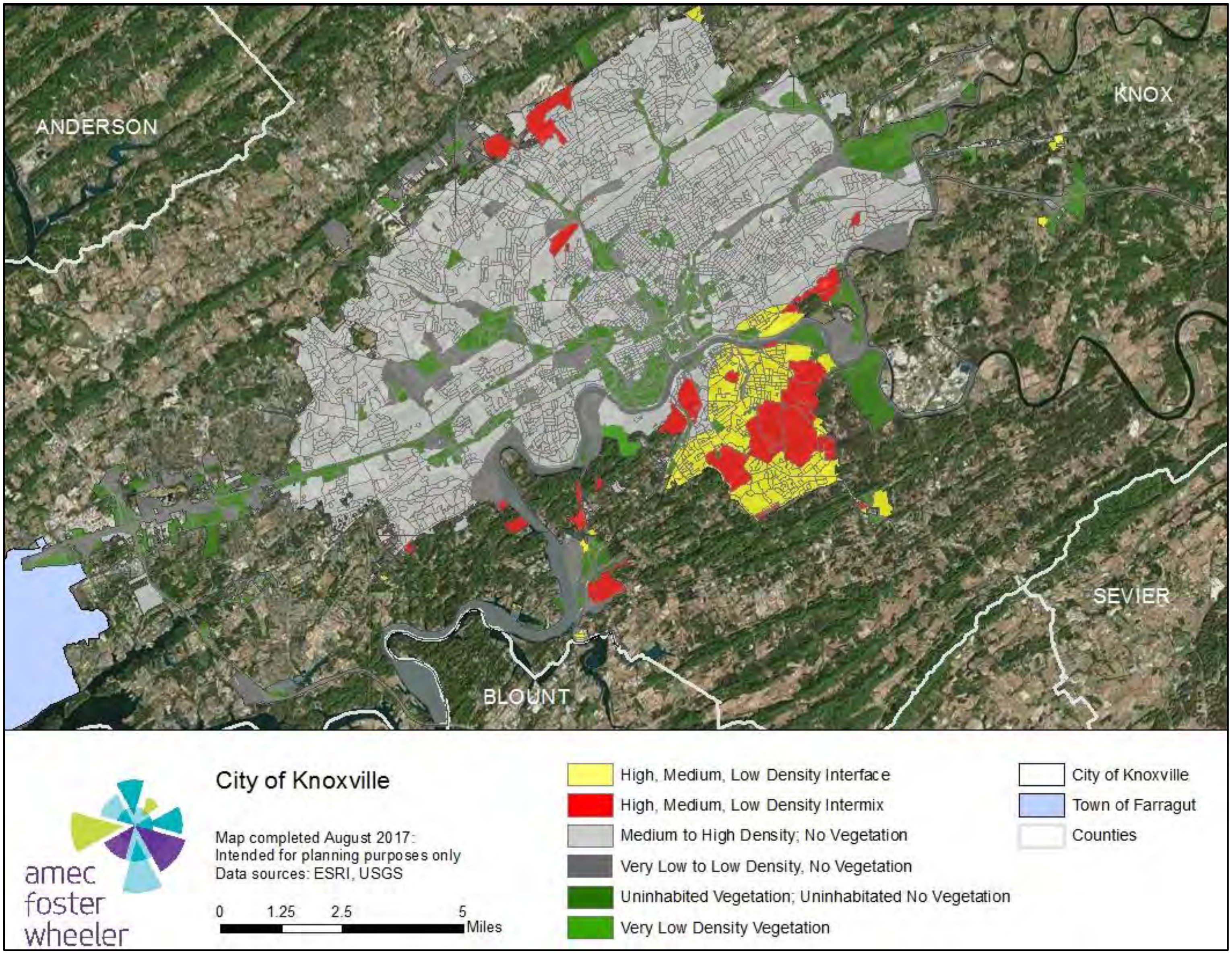
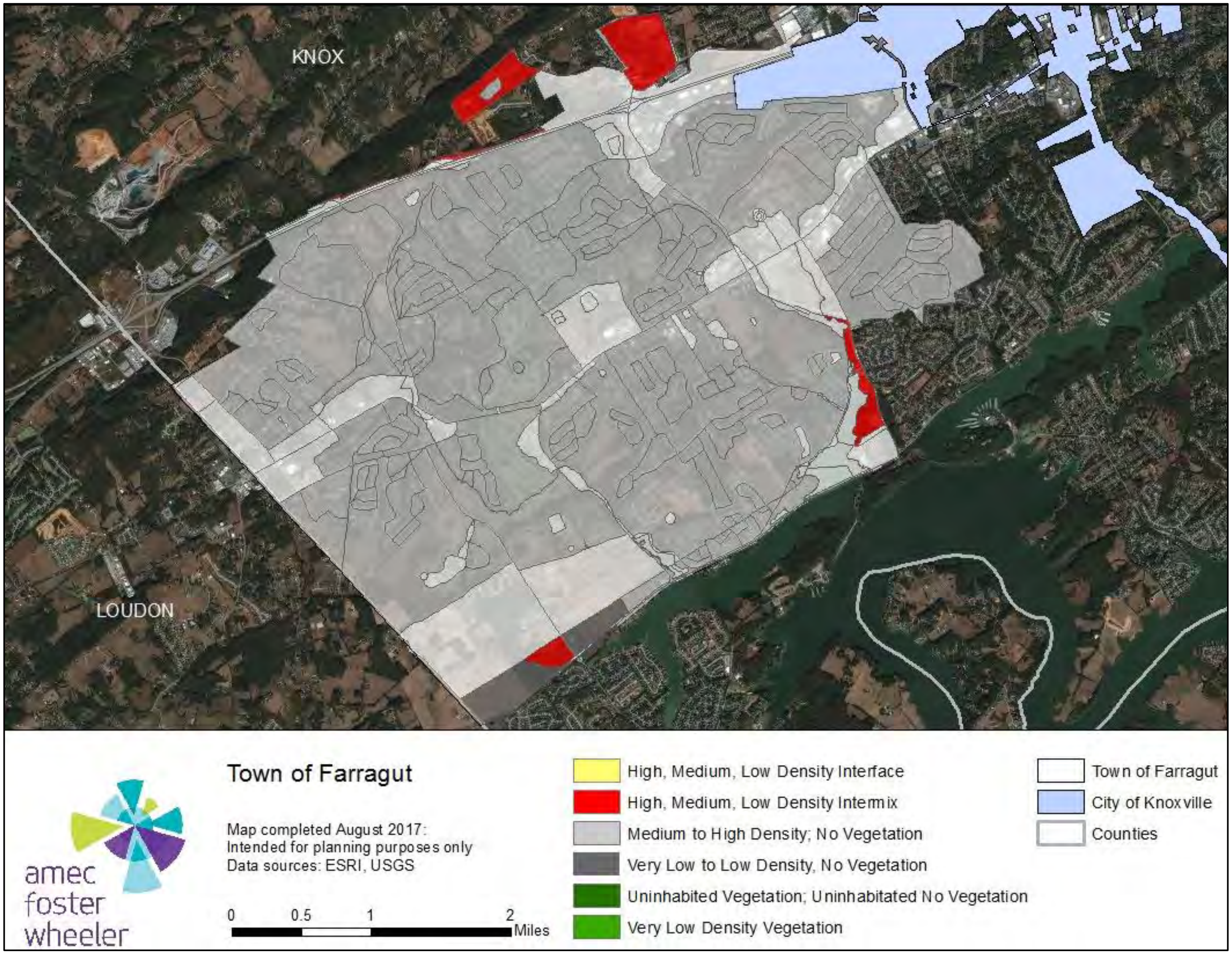


Figure 3.53 Wildland-Urban Interface (WUI) for Town of Farragut



Wildfire can occur naturally from a lightning strike or lava; however, most are caused by humans. As many as 84 percent of wildland fires in the U.S. are caused by humans either intentionally or by human activities. The main culprit of human-caused wildfires in the planning area and throughout the U.S. is caused by debris burning which equates to 29 percent of human-caused wildfires, then arson with 21 percent, and equipment use at 11 percent. These fires start in or near where people live or where people choose to do recreational activities. According to the National Interagency Fire Center, 72% of all human-caused fires are started in Southern and Eastern states. The table below shows that 84 percent of the wildland fires in the U.S. were human caused.

	Human Cause	Lightning Cause
Number of Fires	1,272,076	245,446
Percent of Fires	84	16
Acres Burned	1,932,998	3,829,172
Percent of Acreage	34	66

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. Fuel 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.

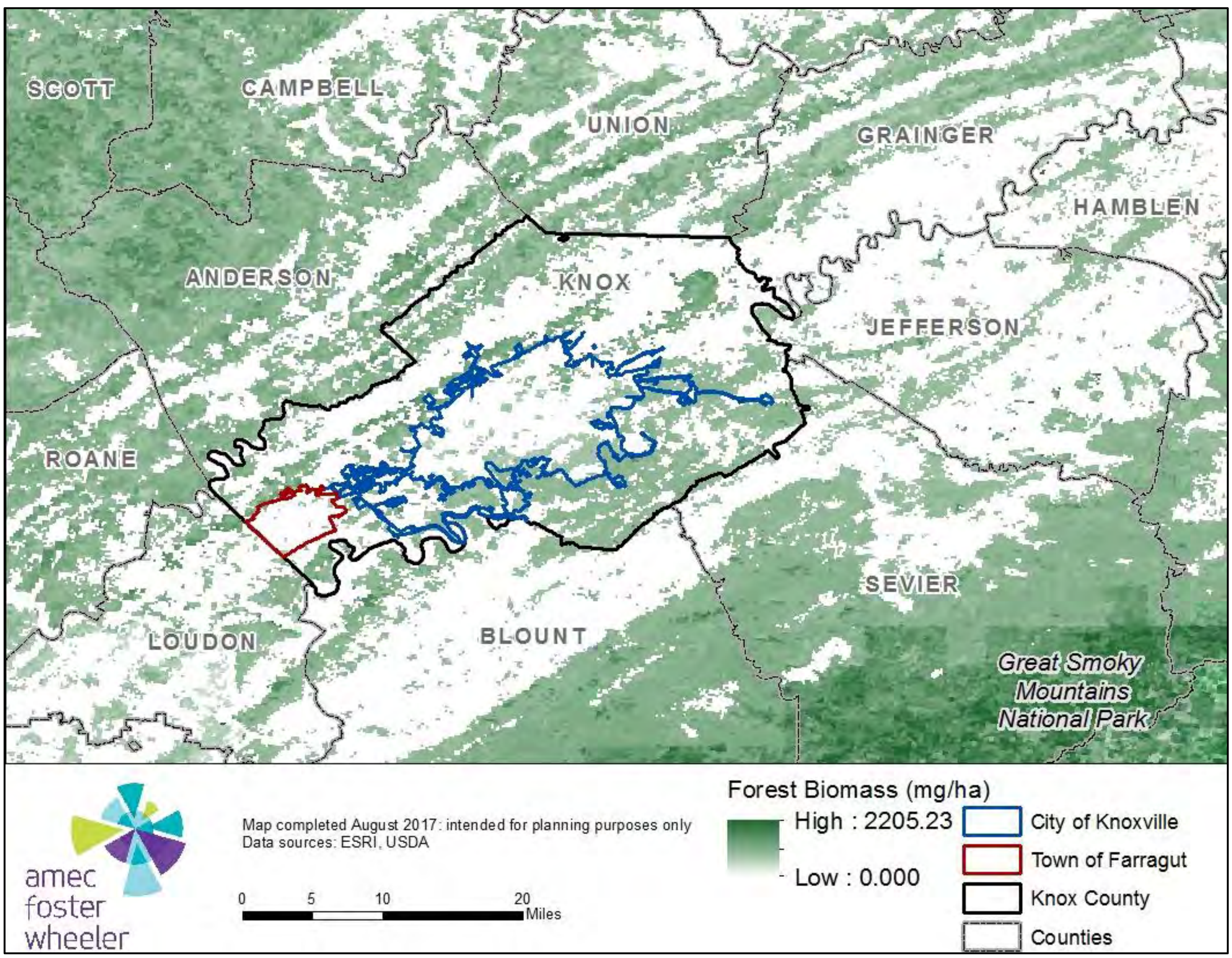
However, wildfires are a natural occurrence and part of a crucial cycle in the planning area's ecosystem. Some plants like evergreens cannot reproduce without fire because fire breaks open the outside coating of seeds, stimulating germination. Also, wildfires initiate a crucial natural process of breaking down organic matter into soil nutrients, stimulating new growth. If all fire is suppressed, dead vegetation and shrubs begin to build up to unnatural levels in a forest, creating more fuel for larger, uncontrollable wildfires to occur. Therefore, the threat of natural wildfires can be reduced by burning away accumulated fuels through planned fires.

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 3.54 below, it depicts the continuous forest biomass in the East Tennessee region. The planning area is outlined in black reflecting a small area of forest within the county but surrounded by heavily wooded areas. According to Forest Inventory & Analysis Factsheet from State of Tennessee Department of Agriculture, Knox County has less than 25 percent of forest in its area.

Figure 3.54 Continuous U.S. Forest Biomass



Previous Occurrences

According to the Tennessee Department of Agriculture, Division of Forestry, Knox County had 46 wildfires that burned 840 acres between 2006 and 2010. There were no fatalities or injuries reported in association with these wildfires. Structural damage is reported independently of the wildfire statistics and therefore it is unknown if there was any structural damage associated with the wildfire events. Table 3.30 details wildfire occurrences in the planning area 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.

For 2011 through 2016, data was obtained from the Tennessee Fire Incident Reporting System (TFIRS) and includes incident reporting from Karns VFD, Knoxville City Fire Department, and the Rural Metro Fire Department. For this reporting period, there were a total of 129 forest/woods/wildland fire events that burned 351 acres. There were no fatalities or injuries reported in association with these wildfires. Again, structural damage is reported independently of the wildfire statistics and therefore it is unknown if there was any structural damage associated with the wildfire events.

Table 3.30 Wildfires, Knox County, 2006-2010 and 2011-2016

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

Year	# Fires	Acres Burned
2011	13	4
2012	31	229
2013	10	14
2014	30	74
2015	11	8
2016	34	22
Totals	**129**	**351**

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

Debris burning is the number one ranking cause of these wildfires in the planning area, followed by arson, campfires, power lines, children, and sparks from railroad lines.

Outside of the Knox County planning area, but within neighboring Sevier County, wildfires in 2016 became one of the largest natural disasters in the history of Tennessee. In late November 2016, a complex set of wildfires impacted the cities of Pigeon Forge and Gatlinburg, both near the Great Smoky Mountains National Park. The fires resulted in three deaths in the City of Gatlinburg and 11 deaths in the adjacent Sevier County area, either directly from the fire or as a consequence of attempting to flee the fire. In addition, the wildfires caused over 130 injuries; damaged or destroyed approximately 2,500 structures, and burned approximately 17,000 acres. Over 14,000 residents and visitors evacuated Gatlinburg and the adjacent areas in danger from the fires. Following a presidential disaster declaration, assistance through FEMA provided over $3.4M in individual assistance and $3.8M in public assistance for recovery efforts.

The wildfires were driven primarily by weather, specifically, very strong winds, in combination with exceptional drought conditions. An after-action report prepared following the event identified numerous actions to better prepare the community for potential wildfires or other relevant hazards in the future. The recommendations addressed a broad range of functions including command staff and incident management; operations; interagency communications; public information; logistics; and recovery and humanitarian outreach.

Probability of Future Occurrences

Wildfires occur in the planning area on an annual basis. The average number of wildfires per year for the 6-year period from 2011-2016 was 21.5. 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 during the 2006-2016 reporting period, the potential magnitude/severity is considered to be "negligible". However, it should be noted, the limitations in the method of reporting incidents to the TFIRS system. Incidents are reported as structure or wildland, not both.

Changing Future Conditions

Drought is anticipated to increase in frequency and intensity under projected future scenarios. Drought can lead to dead or dying vegetation, which creates fodder for wildfires within both urban and rural settings. Higher temperatures also reduce the number of days prescribed burning can be performed, which may result in more risk of spontaneous fires. Reduction of prescribed burning will allow growth of understory vegetation, providing more fuel for destructive wildfires. Current trends also suggest increases in the wildland-urban interface, which would put more people in threat of wildfires.

Wildfire Hazard Summary

	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	4-Highly Likely	1-Negligible	1-Limited	2.35 (Medium)
Knox County (unincorporated)	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)
Knox County School District	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 3.31 below.

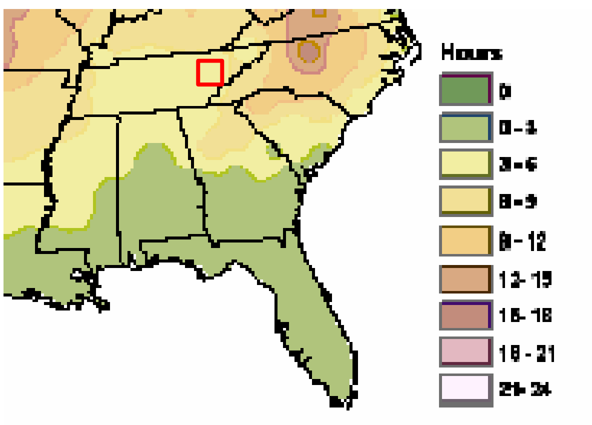
Table 3.31 Snowfall Summary (inches) 1949-2014 National Climatic Data Center Averages

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 3.55 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 3.55. 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 39 winter storm or heavy snow events that have occurred in Knox County between October 1993 and January 2017 and are reported from NCDC records. Occurrences listed prior to 1993 are from newspaper articles either the *Knoxville New Sentinel* or the *Knoxville Journal*.

- **February 16, 2015—** A winter storm tracked through area on the 16 – 17th with the atmosphere favorable for both heavy snow and ice accretion. The highest peaks had up to 6 inches of snow while ice accumulations had up to an inch. In addition, cold weather accounted for three deaths.
- **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 a 24-year period from 1993 to 2017 there were at 39 recorded winter storm events (snow and ice) in the planning area 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 the planning area 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.

Changing Future Conditions

During the last century, the South has experienced a reduction in snowstorm frequency. It is predicted that in a changing climate that there will continue to be fewer snowstorms in the South, however precise conditions for Knox County are difficult to model.

Winter Storm Hazard Summary

	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	4-Highly Likely	1-Negligible	3-Extensive	2.75 (Medium)
Knox County (unincorporated)	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)
Knox County School District	4-Highly Likely	1-Negligible	3-Extensive	2.75 (Medium)

3.2.13 Hazard Profiles Summary

Table 3.32 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 3.32 Planning Significance of Identified Hazard by Jurisdiction

Hazard	Knox County	City of Knoxville	Town of Farragut
Dam Failure	1.55 - L	1.55 - L	1.00 - L
Drought	1.80 - L	1.80 - L	1.80 - L
Earthquake	1.85 - L	1.85 - L	1.85 - L
Expansive Soils	1.00 - L	1.00 - L	1.00 - L
Extreme Temperatures	3.10 - H	3.10 - H	3.10 - H
Flood	3.10 - H	3.10 - H	1.90 - L
Land subsidence & sinkholes	2.90 - M	2.90 - M	2.25 - M
Landslides	2.45 - M	2.45 - M	1.80 - L
Severe Storms	3.10 - H	3.10 - H	3.10 - 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

Hazard	Knox County	City of Knoxville	Town of Farragut
Extreme Temperatures	3.10 - H	3.10 - H	3.10 - H
Flood	3.10 - H	3.10 - H	1.90 - L
Severe Storms	3.10 - H	3.10 - H	3.10 - H
Land subsidence & sinkholes	2.90 - M	2.90 - M	2.25 - M
Winter Storm	2.75 - M	2.75 - M	2.75 - M
Tornadoes	2.25 - M	2.25 - M	2.25 - M
Wildfires	2.35 - M	2.35 - M	2.35 - M
Landslides	2.45 - M	2.45 - M	1.80 - L
Earthquake	1.85 - L	1.85 - L	1.85 - L
Drought	1.80 - L	1.80 - L	1.80 - L
Dam Failure	1.55 - L	1.55 - L	1.00 - L
Expansive Soils	1.00 - L	1.00 - L	1.00 - L

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 the planning area that may be at risk to natural hazards.

Total Exposure of Population and Structures

Table 3.33 shows the total population, 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. It should be noted that HAZUS MR5 uses 2010 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 contents exposures are in the City of Knoxville.

Table 3.33 Total Exposure for Knox County, City of Knoxville, and Town of Farragut

Jurisdiction	2010 Population	2016 Population Estimate	Building Count	Building Exposure ($)	Contents Exposure ($)	Total Exposure ($)
Knox County (Unincorporated)	232,676	247,611	94,455	$20,972,437,000	$ 17,807,364,000	$38,779,801,000
City of Knoxville	178,874	186,239	65,561	$9,898,125,000	$ 14,042,365,000	$23,940,490,000
Town of Farragut	20,676	22,282	8,386	$2,168,952,000	$1,618,442,000	$3,787,394,000
Total	**432,226**	**456,132**	**168,403**	**$33,039,514,000**	**$33,468,171,000**	**$66,507,685,000**

Source: HAZUS MR5

Table 3.34 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 KGIS is broken down into jurisdictions according to available census blocks.

Table 3.34 Building Counts by Usage Type

Jurisdiction	Residential	Commercial	Industrial	Agricultural	Religious	Government	Education	Other	TOTAL
Knox County (Unincorporated)	90,148	2,079	262	1,656	102	57	44	106	94,455
City of Knoxville	59,649	4,735	428	223	19	212	68	227	65,561
Town of Farragut	8,100	197	6	45	10	5	5	18	8,386
Total	**157,897**	**7,011**	**698**	**1,924**	**131**	**274**	**117**	**351**	**168,403**

Source: KGIS, HAZUS MR5

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 3.35 gives the categories used to determine critical facilities and infrastructure along with the examples of each category.

Table 3.35 Critical Facilities and Infrastructures in Planning Area

Critical Facilities			
Community Service	Health Clinic Post Office Veterinary	Shopping Center Library Recycling Center	Other Solid Waste
Daycare/ Preschool			
Emergency	Fire Facility Police Sheriff	Fire Station Recue Facility Veterinary	Highway Patrol Rescue Station
Government	Facility	Main Office	Office
Health Service	Assisted Living Medically Service	Hospital	Medical Clinic
School	College / University Private Primary Public Elementary Public Middle	Pre-K Private Secondary Public High Public Other	Private Primary Private Other Public Intermediate Technical / Vocational
Nursing Home			
Critical Infrastructure			
Bridge			
Dam			
Emergency Infrastructure	Control Tower	Utility	
Cell Tower			
Transportation	Airport	Bus Depot	

Source: KGIS

Table 3.36 is an inventory of critical facilities and infrastructure (based on available data) in the planning area.

Table 3.36 Inventory of Critical Facilities and Infrastructure by Jurisdiction

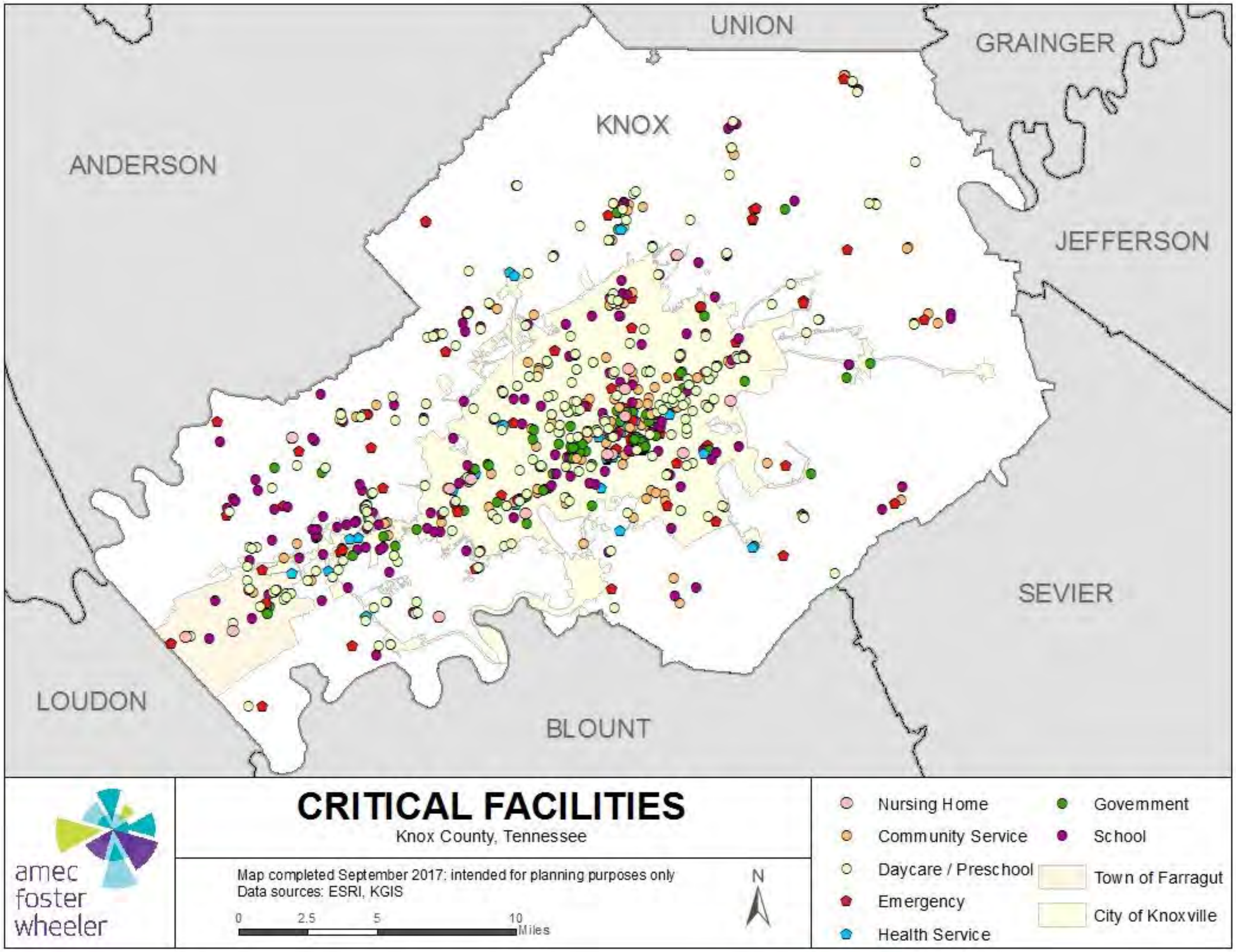
Facility	City of Knoxville	Town of Farragut	Knox County Unincorporated	Total
Community Service	80	2	28	110
Daycare / Preschool	139	12	78	229
Emergency	35	5	28	68
Government	81	4	11	96
Health Service	24	1	10	25
Nursing Home	11	2	3	16
School	104	8	66	178
Bridge	36	0	17	53
Dam	1	0	1	2
Emergency	11	0	6	17
Cell Tower	87	4	122	213
Transportation	5	0	3	8
Totals	**614**	**38**	**373**	**1,025**

Sources: KGIS, HIFLD

Figure 3.56 through Figure 3.61 on the following pages show the location of critical facilities and bridges in Knox County. Figure 3.56 provides locations of the critical facilities in the entire planning area. Figure 3.57 and Figure 3.58 provide more detailed locations of the critical facilities in the City of Knoxville and the Town of Farragut.

Figure 3.59 through 3.61 provide the locations of critical infrastructure.

Figure 3.55 Critical Facilities in Knox County



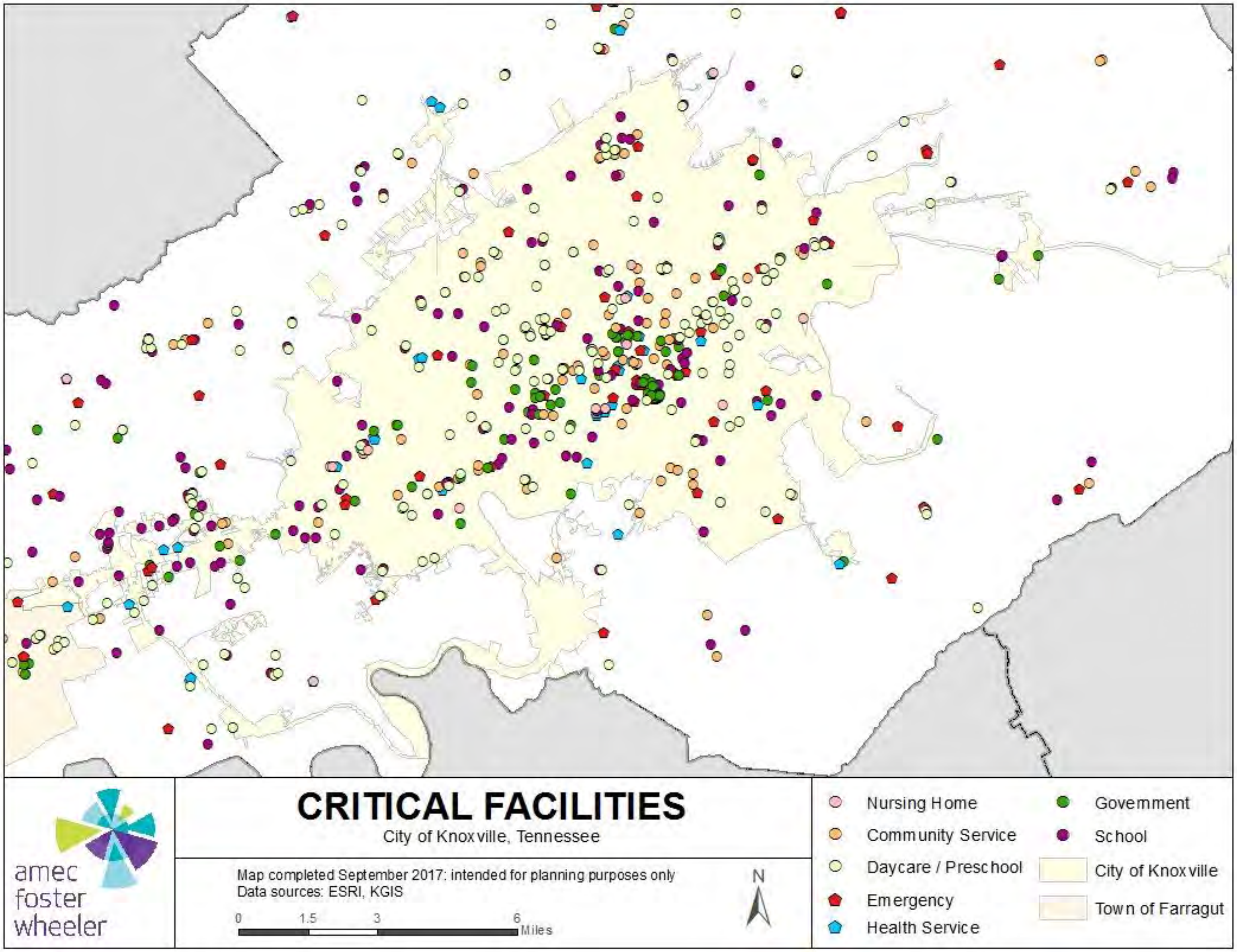

CRITICAL FACILITIES
City of Knoxville, Tennessee
Map completed September 2017: intended for planning purposes only
Data sources: ESRI, KGIS
0 1.5 3 6 Miles
N
Nursing Home
Community Service
Daycare / Preschool
Emergency
Health Service
Government
School
City of Knoxville
Town of Farragut
amec foster wheeler

Figure 3.58 Critical Facilities in Town of Farragut

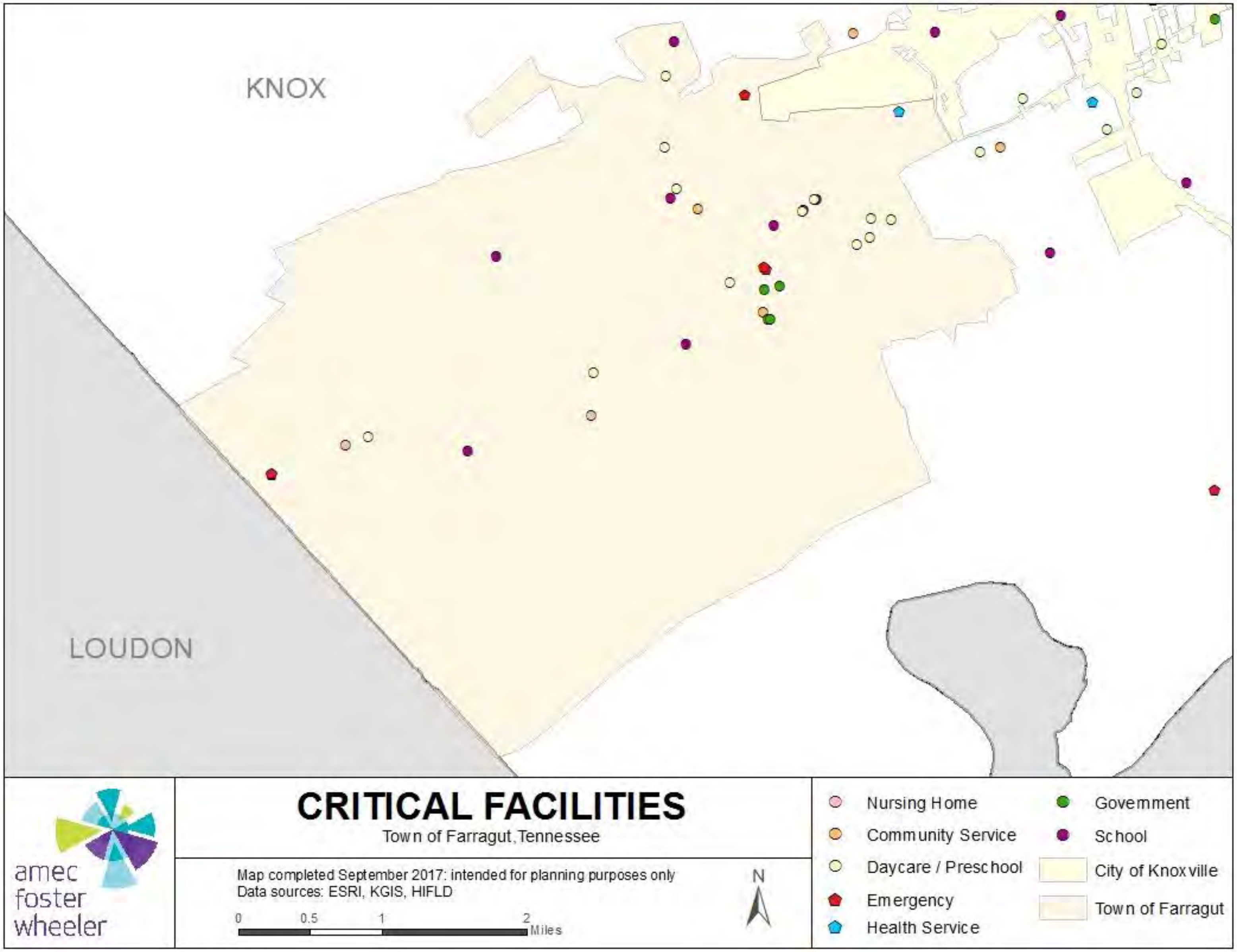


Figure 3.59 Critical Infrastructures in Knox County

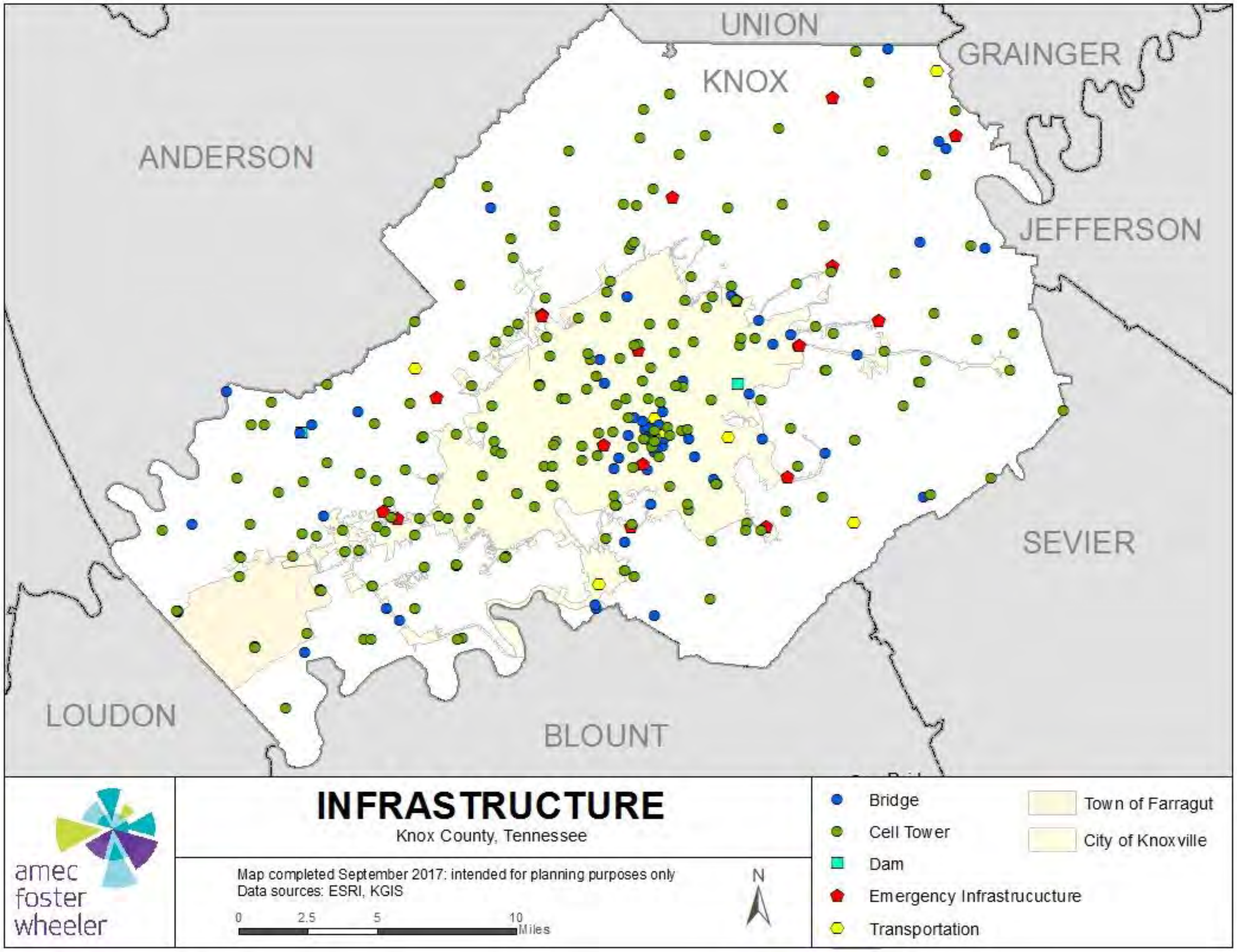


Figure 3.60 Critical Infrastructures in City of Knoxville

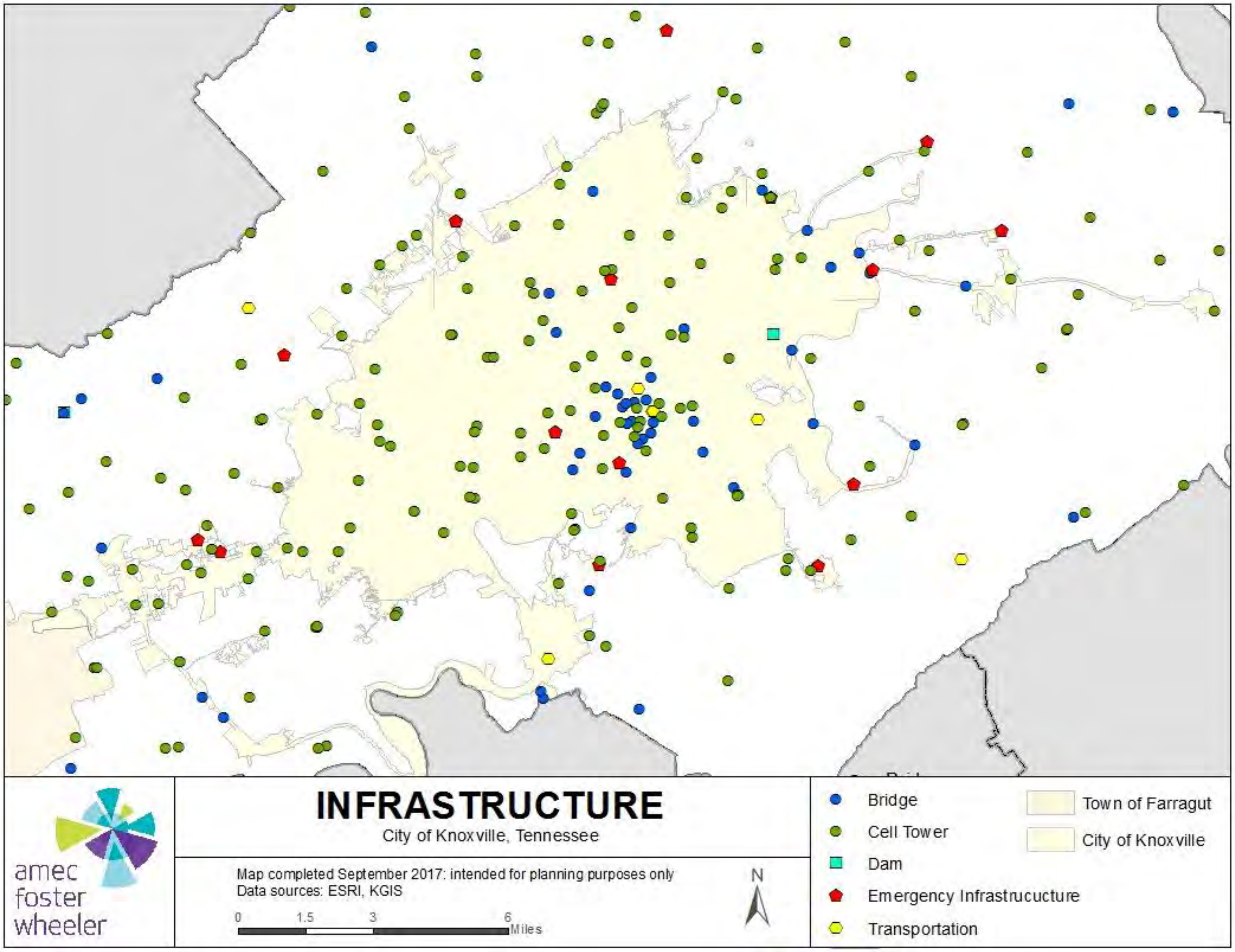
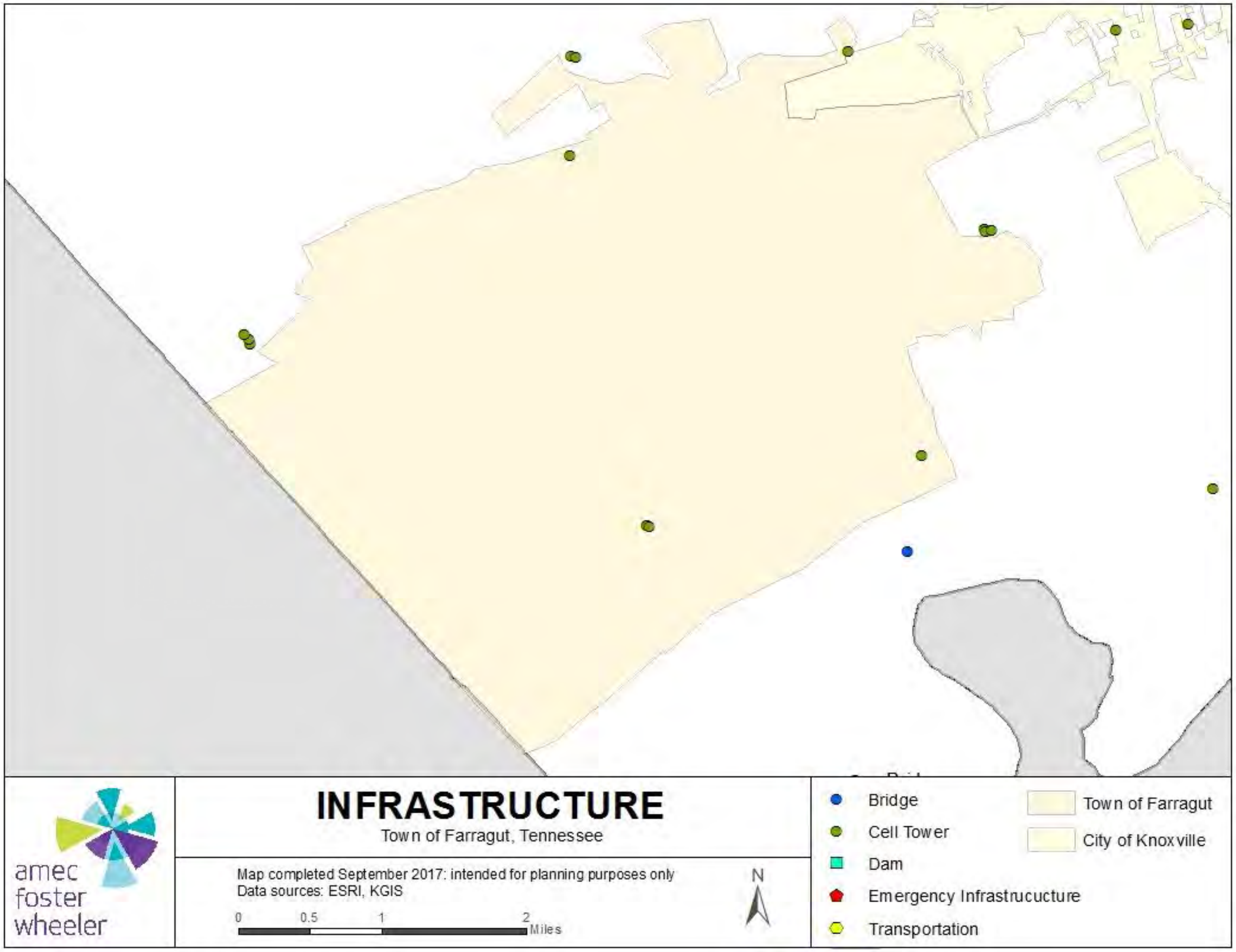


Figure 3.61 Critical Infrastructures in Town of Farragut



Other Assets

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

- The planning area 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 the planning area, specific assets include the following:

- Natural Resources:
  - There are 58 known species in the planning area 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.

Potential Losses to Existing Development

The planning area 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. Dam or levee failure is typically an additional or secondary impact of another disaster such as flooding or earthquake. The impacts to the planning area 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.

GIS analysis of populations and development in dam inundation areas would provide the most accurate results in terms of estimates of potential loss in the unlikely event of failure. However, 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

Flooding due to a dam failure event is likely to exceed the special flood hazard areas regulated through local floodplain ordinances. Future development located downstream from dams and within inundation zones would increase vulnerability to this hazard. Knox County should consider the dam failure hazard when permitting development downstream of the high hazard and significant hazard dams.

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. Approximately 20-percent of the land area of the planning area 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 3.37 provides the loss of use estimates if water supply was lost for the jurisdictions in Knox County.

Table 3.37 Economic Damage Estimates for Loss of Water Supply

Jurisdiction	2016 Population Estimate	Loss of Water Estimate ($93 per person per day)
Knox County (Unincorporated)	247,611	$23,027,823
City of Knoxville	186,239	$17,320,227
Town of Farragut	22,282	$2,072,226
Total	**456,132**	$42,420,276

Source: Population from 2016 Census Estimate, FEMA BCA Reference Guide

Another impact of drought would be to agricultural production in the planning area. 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 the planning area was $1,068. The HMPC realizes that USDA claims only represent a portion of the actual damages. In 2017, 83 percent of insurable crops were insured in the planning area.

Table 3.38 Economic Damage Estimates for Crop Loss

10-Year Drought Insurance Paid	Adjusted 10-Year Drought Losses (considering 83% insured)	Estimated Annualized Losses	2016 Value of Crops	Annualized Crop Loss Ratio (Losses/Value)
$8,871	$10,687	$1,068	$8,672,000	0.01%

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

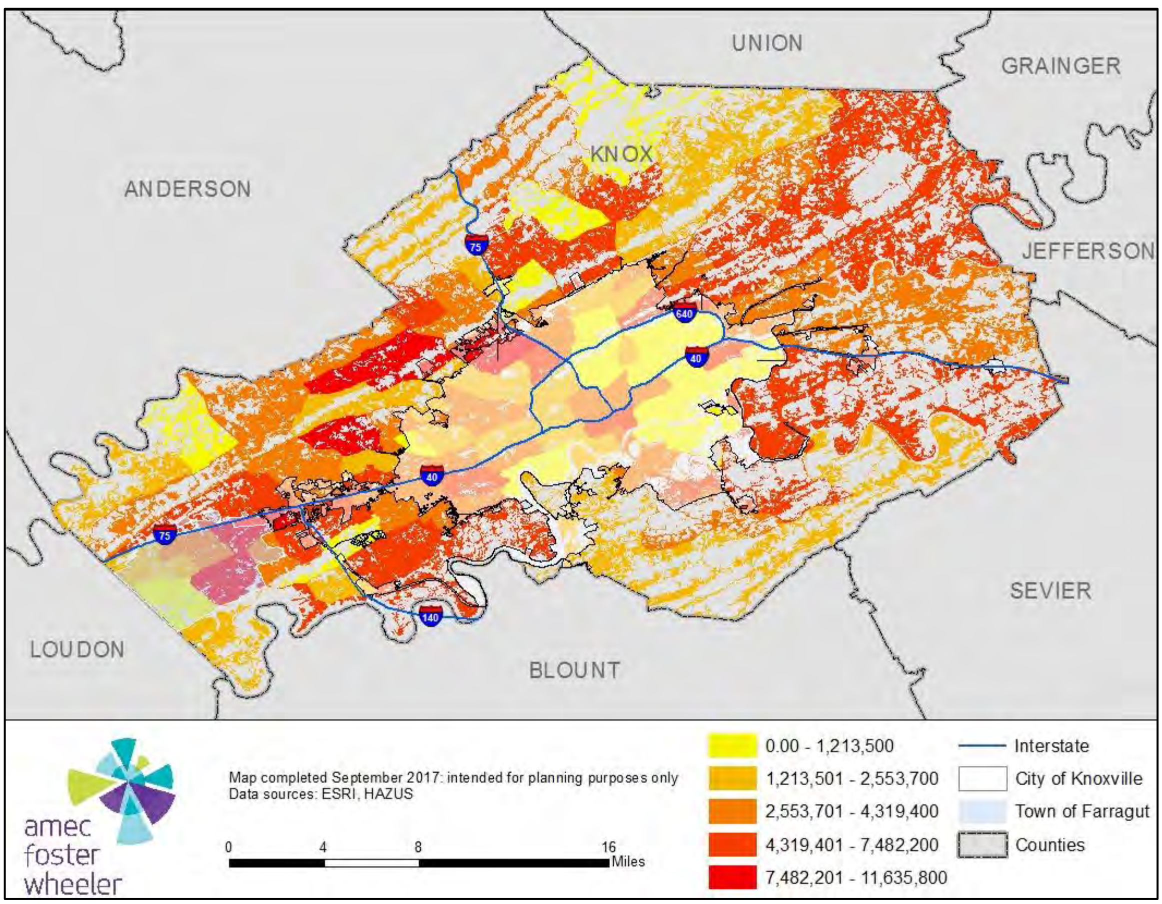
Planning Significance: Low

As discussed in the Hazard Profile section, the 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 3.62.

Figure 3.62. 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 3.39 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 3.39 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 3.40 Earthquake Loss Ratio--2,500 Year Earthquake Event

Jurisdiction	Building Exposure ($)	Structural damage ($)	Loss Ratio
Knox County (Unincorporated)	$20,972,437,000	$623,152,630	2.97%
City of Knoxville	$9,898,125,000	$1,442,986,480	14.58%
Town of Farragut	$2,168,952,000	$87,702,390	4.04%
Total	$33,039,514,000	$2,153,841,500	6.52%

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 3.41 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 when compared to the rest of the United States.

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 with limited financial resources, such as those with incomes 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 2015 American Community Survey 5-Year Estimates, Table 3.42 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 17.2 percent. The unincorporated county has the highest percentage of residents under 5, at 3.6 percent, and the City of Knoxville has the highest percentage of population below the poverty level, at 25.7 percent.

Table 3.42 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)	33,714	13.5	8,902	3.6	Not available for this geography
City of Knoxville	25,263	13.5	16,476	5.9	25.7
Town of Farragut	3,676	17.2	834	3.9	4.5
Total Knox County	62,653	14.1	26,216	5.9	16.0

Source: 2015 American Community Survey 5-Year Estimates, U.S. Census Bureau, http://factfinder.census.gov;

Table 3.43 Claims Paid in Knox County for Crop Loss as a Result of Frost/Freeze (2007 – 2016)

10-Year Drought Insurance Paid	Adjusted 10-Year Drought Losses (considering 83% insured)	Estimated Annualized Losses	2016 Value of Crops	Annualized Crop Loss Ratio (Losses/Value)
$28,825	$34,729	$3,476	$8,672,000	0.04%

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 and other care facilities may be at increased risk if there is no alternate power source. According to the Tennessee Care Planning Council (http://www.caretennessee.org/), there are 16 long-term, nursing, and Medicare rehabilitation facilities in the planning area. If these facilities lost power, special needs populations 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 the planning area 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 riverine flood scenario were generated utilizing FEMA's HAZUS-MH MR4 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 3.44, the unincorporated county would have the highest economic losses in terms of number, dollar loss, and building loss ratio.

Table 3.44 One Percent Annual Chance Flood Loss Summary, Knox County

Jurisdiction	# of Damaged Buildings	Building Damage	Building Loss Ratio
Knox County (unincorporated)	486	$116,930,000	0.55%
City of Knoxville	23	$42,104,000	0.42%
Town of Farragut	7	$3,578,000	0.16%
Total	**575**	**$162,612,000**	**0.49%**

This analysis does not take into account damages caused by flash flooding 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 1-percent annual chance flood event 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 3.45 provides the numbers of people that would be displaced and those that would need shelter in each jurisdiction. According to this analysis, over 8,892 people in the planning area are at risk of being displaced if a

1-percent annual chance flood event impacted their area. The jurisdiction with the potential for the most displaced people is the Knox County with 6,735 displaced people. Figure 3.63 presents the displaced populations by census block, clipped to the one-percent annual chance flood. Figure 3.64 and Figure 3.65 display the displaced population for the City of Knoxville and the Town of Farragut, clipped to the floodplain.

Table 3.45 One Percent Annual Chance Flood, Displaced Population, Knox County

Jurisdiction	Displaced Population
Knox County (unincorporated)	6,735
City of Knoxville	1,944
Town of Farragut	213
Total	**8,892**

Figure 3.63. Estimated Population Displaced by 1-Percent Annual Chance Flood in Knox County

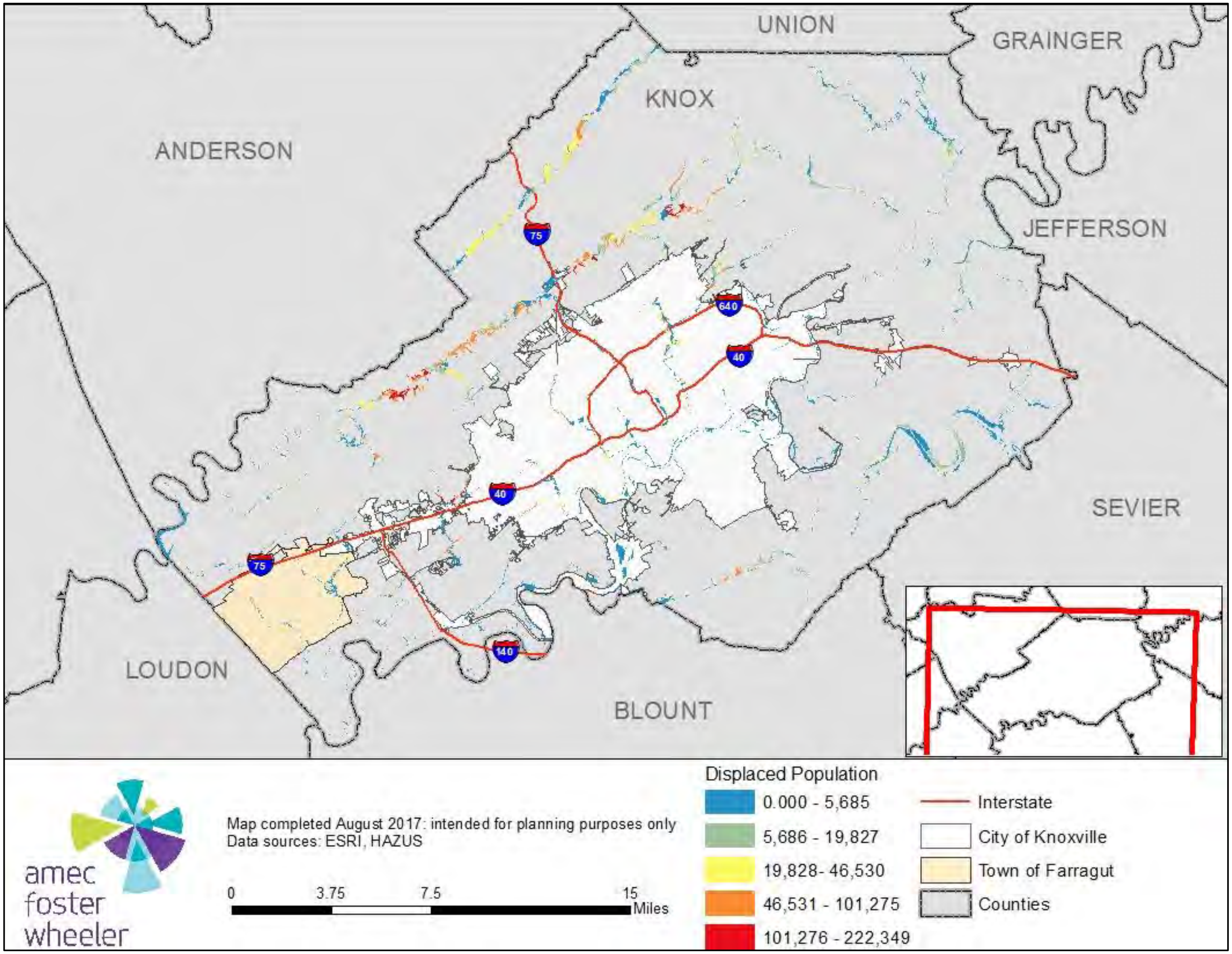


Figure 3.64. Estimated Population Displaced by 1-Percent Annual Chance in the City of Knoxville

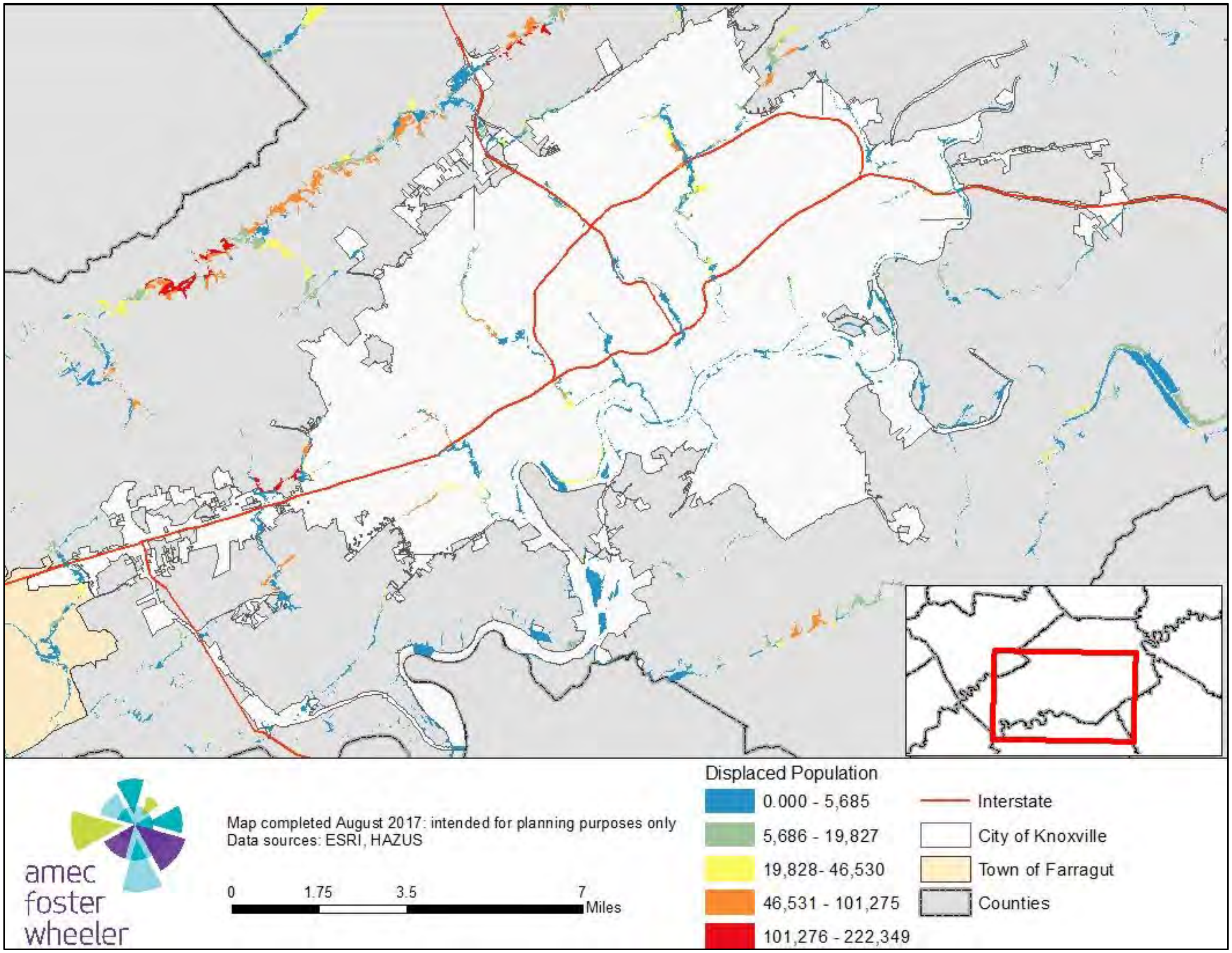
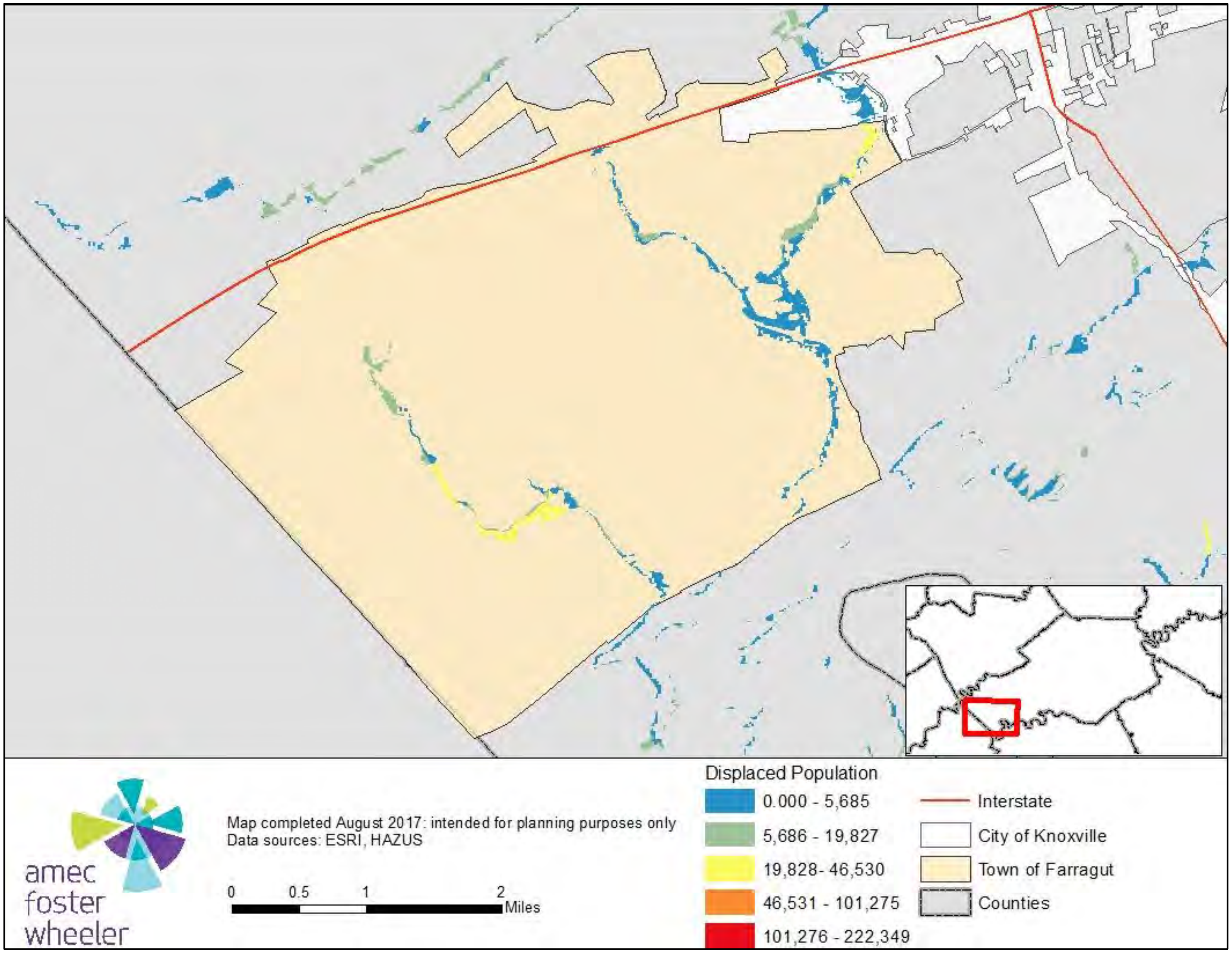


Figure 3.65. Estimated Population Displaced by 1-Percent Annual Chance Flood in the Town of Farragut



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 3.46 Counts and Types of Damaged Buildings, 1-Percent Annual Chance Flood Event

Jurisdiction	Residential	Commercial	Industrial	Agricultural	Religion	Government	Education	Total
Knox County	486	0	0	0	0	0	0	**486**
City of Knoxville	69	13	0	0	0	0	0	**82**
Town of Farragut	4	3	0	0	0	0	0	**7**
Total	**559**	**16**	**0**	**0**	**0**	**0**	**0**	**575**

Table 3.47 Structure Losses, 1-Percent Annual Chance Flood Event

Jurisdiction	Building Damage	Contents Damage	Total Damage
Knox County (unincorporated)	$116,930,000	$93,452,000	$210,382,000
City of Knoxville	$42,104,000	$81,153,000	$123,257,000
Town of Farragut	$3,578,000	$5,809,000	$9,387,000
Total	**$162,612,000**	**$180,414,000**	**$343,026,000**

Table 3.48 Other Economic Losses by County, 1-Percent Annual Chance Flood Event

Business Interruptions	U.S. Dollars
Inventory Loss ($)	11,230,000
Relocation Loss ($)	350,000
Capital Related Loss ($)	830,000
Wage Loss ($)	1,390,000
Rental Income Loss ($)	130,000
Total	**$13,930,000**

Table 3.49 Building Damage Loss Ratio, 1-Percent Annual Chance Flood Event

Jurisdiction	Building Exposure	Building Damage	Loss Ratio (%)
Knox County (unincorporated)	$20,972,437,000	$116,930,000	0.55%
City of Knoxville	$9,898,125,000	$42,104,000	0.42%
Town of Farragut	$2,168,952,000	$3,578,000	0.16%
Total	**$33,039,514,000**	**$162,612,000**	**0.49%**

Figure 3.66 through Figure 3.68 show the combined estimated losses to structures, contents, and other associated losses. The areas shaded red are those areas that would experience greater loss.

Figure 3.66. Estimated Financial Losses from 1-Percent Annual Chance Flood in Knox County

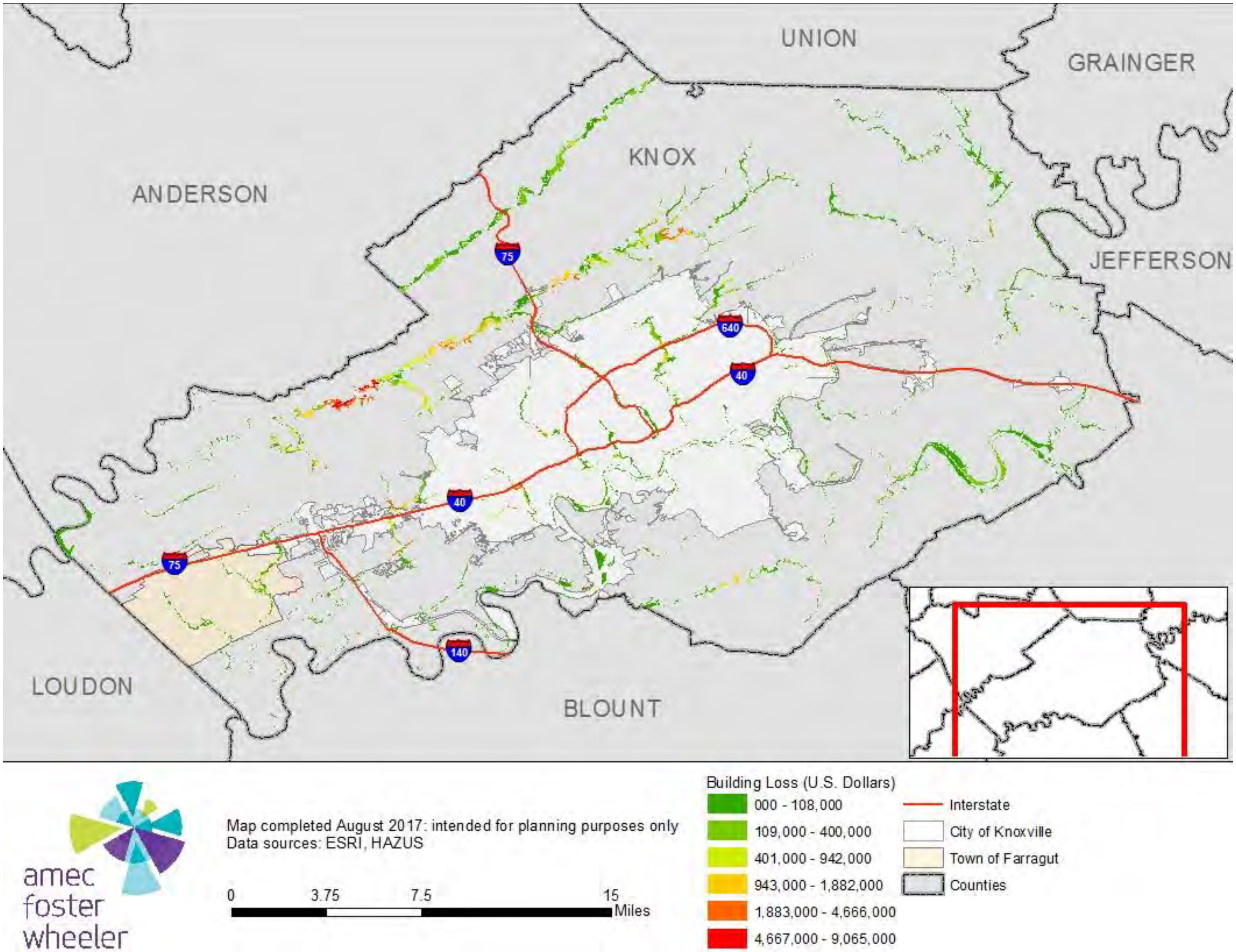


Figure 3.67. Estimated Financial Losses from 1-Percent Annual Chance Flood in the City of Knoxville

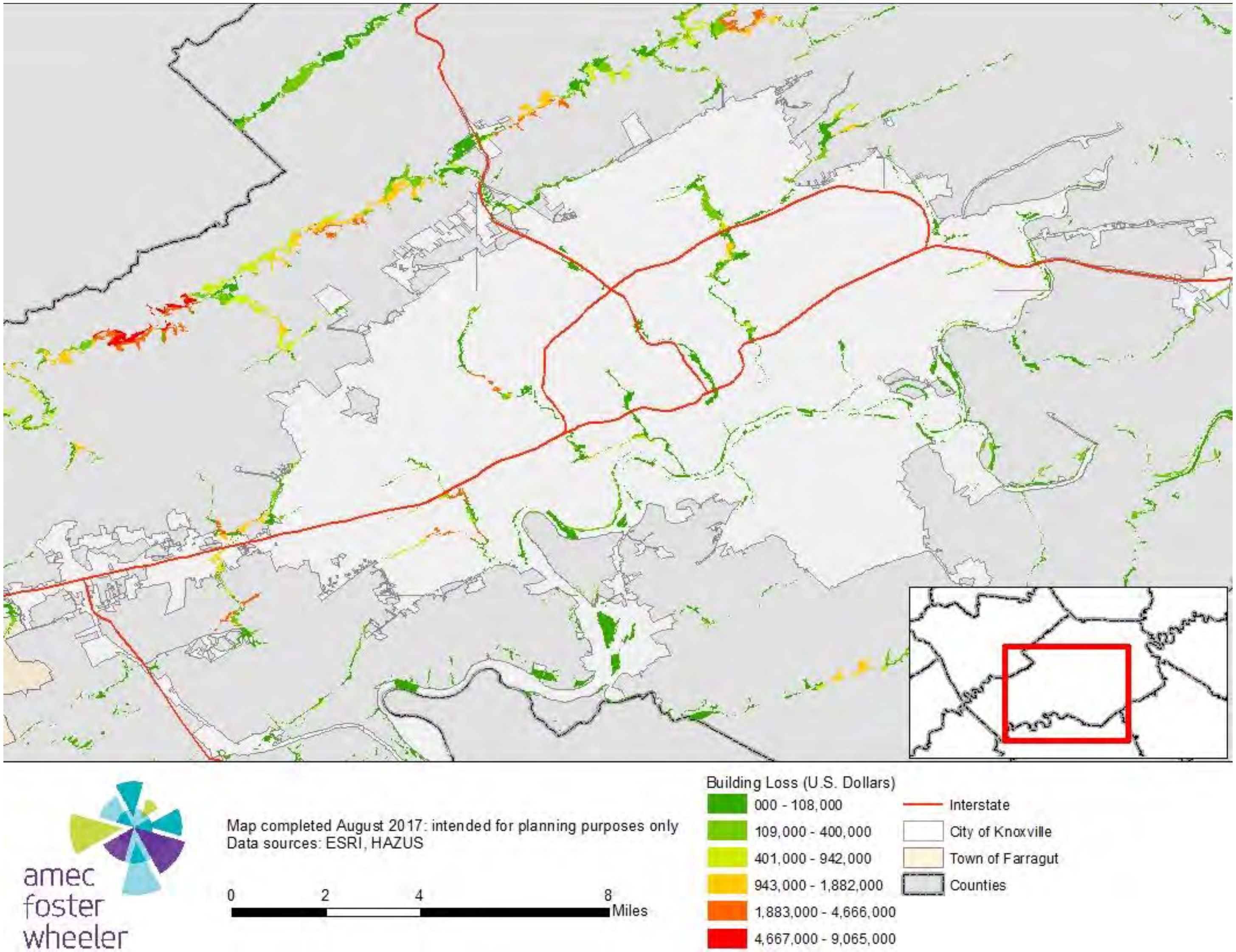
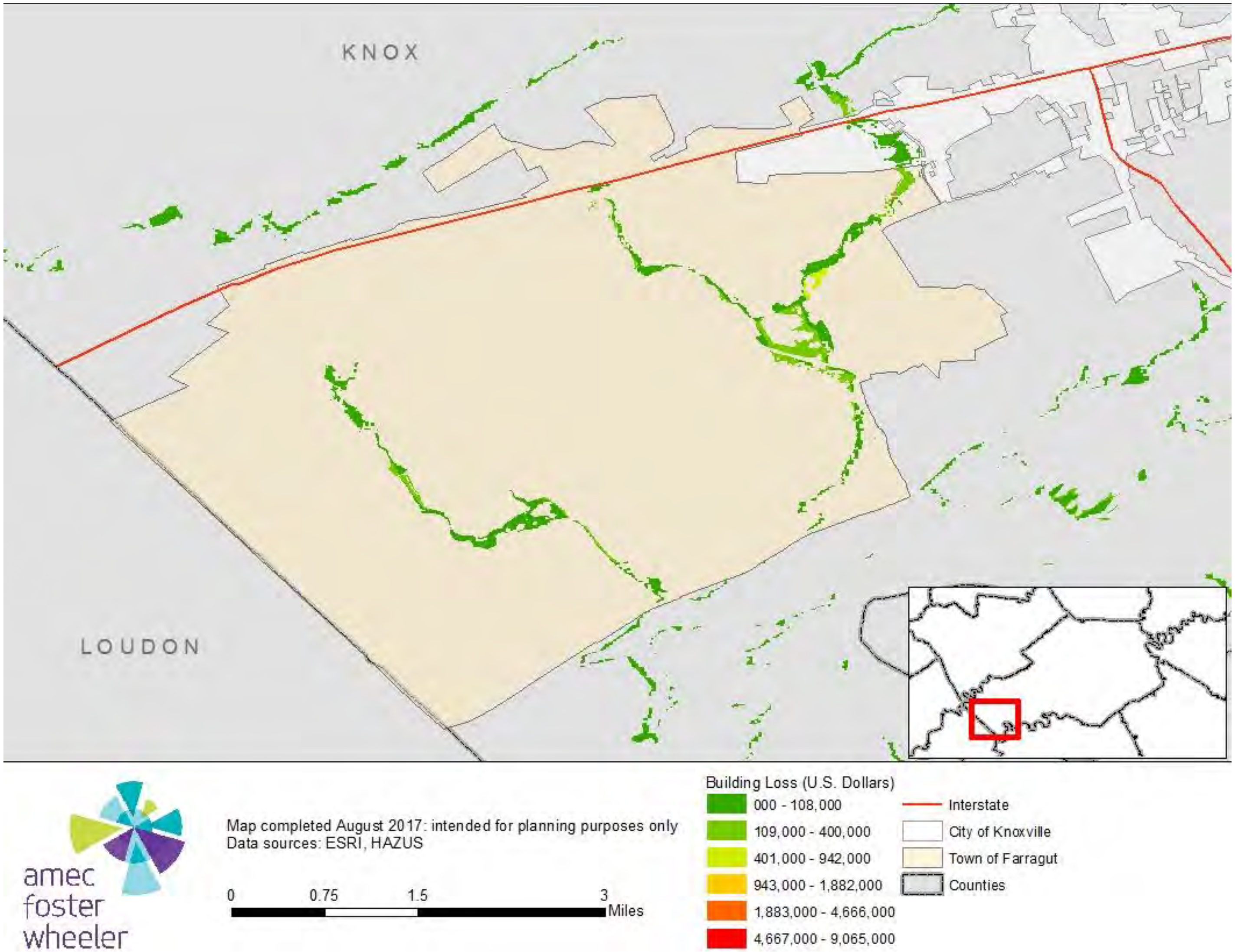


Figure 3.68. Estimated Financial Losses from 1-Percent Annual Chance Flood in Town of Farragut



Agricultural Impacts

In addition, USDA crop insurance claims as a result of flood and excessive moisture damage has averaged $20,256 per year from 2007 to 2016 and total $168,126 for the period.

Table 3.43 Claims Paid in Knox County for Crop Loss as a Result of Flood/Excessive Moisture/Rain (2007 – 2016)

10-Year Drought Insurance Paid	Adjusted 10-Year Drought Losses (considering 83% insured)	Estimated Annualized Losses	2016 Value of Crops	Annualized Crop Loss Ratio (Losses/Value)
$ 168,126.00	$202,561	$20,256	$8,672,000	0.23%

Critical Facilities, Pipelines, and Power Infrastructure at Risk

Available critical facilities data was compared to the 1-percent annual chance floodplain to show the locations of critical facilities in relation to the floodplain. According to this analysis, there are 11 facilities within the floodplain. Table 3.50 provides the names of the critical facilities determined to be in the 1-percent annual chance floodplain.

Table 3.50 Critical Facilities located in the 1-Percent Annual Chance Floodplain

Jurisdiction	Type	Critical Facility Name
Knox County (unincorporated)	FIRE STATION	Rural Metro Station #30 Lena Lane
Knox County (unincorporated)	OFFICE	Kiddie Station Child Development Ctr
Knox County (unincorporated)	UTILITY	KUB SUB STATION KARNS
Knox County (unincorporated)	AIRPORT	Robertson Farm Airport
City of Knoxville	RECYCLING CENTER	Old Kroger Recycling Center (Fountain
City of Knoxville	RECYCLING CENTER	Knoxville Recycled Fiber Company
City of Knoxville	OFFICE	Knox County Stormwater Department
City of Knoxville	OFFICE	Children's Center of Knoxville (The)
City of Knoxville	OFFICE	Kids First, Inc.
City of Knoxville	OFFICE	New Fellowship Christian Academy
City of Knoxville	AIRPORT	Skyranch Airport

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 Karst data, it appears that sinkholes are more densely populated in unincorporated county and 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, KGIS provided parcel data for each individual home in the county. This was overlaid with USGS Karst's dataset which indicated ever known sinkhole in the county. A 100 foot buffer was added to each sinkhole and the parcel that touched or were within the buffer were considered to damaged buildings. Table 3.51 provides the results of this analysis. There were no critical facilities located within the 100-foot buffer areas.

Table 3.51 Building Counts and Values within 100 feet of Sinkholes in Planning Area

Knox County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	727	32	9	389	10	32	7	24	**1,230**
Cost of Building	$167,040,600	$38,793,500	$21,883,400	$22,257,700	$1,079,700	$302,900	$23,331,400	$420,200	**$275,109,400**
Acres	4,087	372	659	13,887	99	1,554	309	300	**21,266**

City of Knoxville	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	171	17	3	54	6	15	6	6	**278**
Cost of Building	$43,795,600	$31,312,200	$1,020,800	$1,225,200	$1,078,200	$ -	$19,602,800	$115,700	**$275,109,400**
Acres	528	137	27	557	48	647	216	55	**2,216**

Town of Farragut	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	17	3	-	6	-	-	-	-	**26**
Cost of Building	$12,119,400	$5,250,100	$ -	$ -	$ -	$ -	$ -	$ -	**$17,369,500**
Acres	32	13	0	232	0	0	0	0	**278**

Future Development

The Knox County Stormwater Management Manual and Sinkhole Ordinance for the Town of Farragut contains regulations and policies for developments that are located near and/or drain to sinkholes. These include general requirements for placing substances and objects within sinkholes; filling or obstructing sinkhole outlets and springs; stormwater runoff into sinkholes; disturbance in sinkhole drainage area; and building construction in sinkhole drainage areas.

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 from the USDA Soil Survey Database (SSURGO) determined the slope class and the slip potential in the planning area. Areas with a slope of more than 40% weighted average was considered “High Risk Area.” Parcel data from KGIS was overlaid with the high slope areas and high slippage areas. Table 3.52 and 3.53 indicated the building count, value and acres of each parcel that would be at risk. Table 3.54 presents the number and type of critical facilities also at risk.

Table 3.52 Building Counts and Values Over High Slope Class Areas

Knox County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	7,018	183	68	3,034	49	109	6	177	**10,644**
Cost of Building	$1,423,177,500	$146,678,000	$23,587,600	$77,546,700	$8,159,500	$2,858,700	$8,429,600	$17,672,800	**$1,708,110,400**
Acres	25,084	1,394	1,124	38,319	520	3,863	99	1,382	**71,785**

City of Knoxville	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	2,904	144	46	1,201	21	78	4	69	**4,467**
Cost of Building	$672,090,800	$135,427,200	$21,651,000	$17,978,300	$6,872,500	$2,764,700	$ -	$3,107,000	**$859,891,500**
Acres	5,572	1,007	705	5,122	363	2,530	28	388	**15,715**

Town of Farragut	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	3	-	-	2	-	-	-	1	**6**
Cost of Building	$1,215,600	$ -	$ -	$7,300	$ -	$ -	$ -	$ -	**$1,222,900**
Acres	30	0	0	48	0	0	0	54	**132**

Table 3.53 Building Counts and Values Over High Slippage Areas

Knox County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	37,545	780	257	10,868	269	434	34	1,172	**51,359**
Cost of Building	$6,459,722,000	$722,876,700	$196,046,200	$230,334,100	$35,590,000	$42,601,000	$57,419,300	$29,407,200	**$7,773,996,500**
Acres	78,234	4,606	3,025	98,769	1,498	8,481	653	3,962	**199,228**

City of Knoxville	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	11,581	442	129	3,575	120	321	19	257	**16,444**
Cost of Building	$2,211,758,800	$485,200	$2,934,000	$65,824,300	$18,706,500	$829,300	$ -	$1,156,400	**$2,301,694,500**
Acres	15,277	2,564	1,325	14,548	865	4,733	366	946	**40,622**

Town of Farragut	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	1,842	28	16	403	5	8	3	154	**2,459**
Cost of Building	$489,935,900	$69,022,500	$58,417,700	$83,278,300	$ -	$186,100	$662,000	$278,400	**$701,780,900**
Acres	1,598	292	1,341	3,021	24	202	5	304	**6,789**

Table 3.54 Number of Critical Facilities within High Slope and High Slippage Areas

Critical Facility	Nursing Home	Community Service	Daycare	Emergency	Government	Health Service	School
High Potential for Soil Slip							
Knox County (unincorporated)	0	2	6	1	1	2	2
City of Knoxville	0	0	2	1	5	1	3
Town of Farragut	0	0	2	0	0	1	0
Total	0	2	10	2	6	4	5
Slope Gradient Greater than 40%							
Knox County (unincorporated)	0	0	0	0	0	0	0
City of Knoxville	0	0	0	0	2	0	0
Town of Farragut	0	0	0	0	0	0	0
Total	0	0	0	0	2	0	0

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.

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

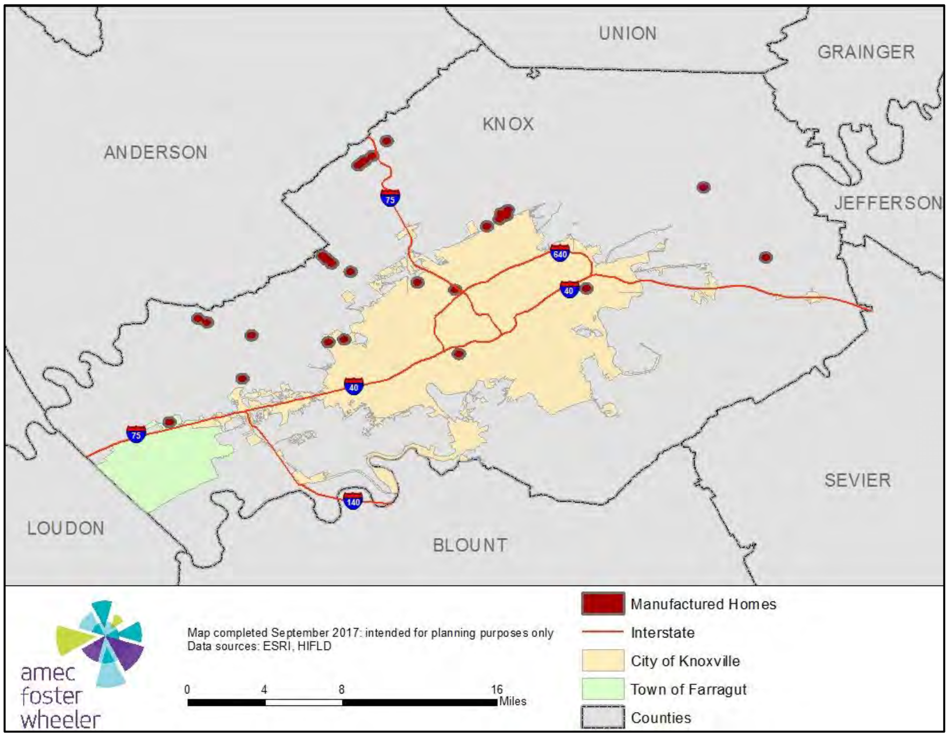
Campers, manufactured homes, barns, and sheds and their occupants are particularly vulnerable as windstorm events in the planning area can be sufficient in magnitude to overturn these lighter structures. Table 3.55 provides the estimated numbers of manufactured homes in each jurisdiction in the planning area.

Table 3.55 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

Figure 3.69 Areas of Manufactured Homes in Planning Area



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 17-year period (2000 – 2017) were reported to be $1.970 Million in property damages. This translates to estimated annualized losses of $115,882.

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 3.56 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 3.56 Tornado Vulnerability Analysis

	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	190	12	$160,700	$1,928,400
City of Knoxville	104	865	56	$118,300	$6,624,800
Town of Farragut	16.09	491	32	$323,000	$1,033,600
Total					**$9,586,800**

Source: Housing Density, Census 2015; Average Home Value 2015 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/intermix areas. To demonstrate how vulnerability to this hazard varies by jurisdiction, the 2010 partial data indicating acreage of Wildland Urban Interface/Intermix areas from the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin-Madison was compared against the corporate boundary layer for the planning area. The identified Wildland-Urban Interface (WUI) area encompasses approximately 88 square miles of interface and 206 square miles of intermix for a total of 294 square miles. This is 47% of the total area of Knox County.

Potential Losses to Existing Development

Wildfires can be responsible for extensive damage to crops, the environment and occasionally residential or business facilities. Homes built in rural areas are vulnerable more since they are in closer proximity to land that is burned and homeowners are more likely to burn trash and debris in rural locations. The vulnerability of structures in rural areas is exacerbated due to the lack of hydrants in these areas for firefighting and the distance required for firefighting vehicles and personnel to travel to respond. Potential losses to crops and rangeland are additional concerns.

Vulnerability to wildfire is predominantly associated with wildland-urban interface areas. The wildland-urban interface is a general term that applies to development interspersed or adjacent to forests and wildlands. To analyze vulnerability to wildfire events and how this varies by jurisdiction, the population and critical facilities located within the wildland-urban interface and intermix areas was calculated.   Tables 3.57 through 59 present this data.

In addition, the August 17, 2001, Federal Register included a list of “urban wildland interface communities within the vicinity of federal lands that are at high risk from wildfire.” The communities were identified as required by the National Fire Plan, a cooperative, long-term effort between various government agency partners with the intent of actively responding to severe wildfires and their impacts to communities while ensuring sufficient firefighting capacity for the future. None of the communities within Knox County were included on this list.

Table 3.57 Building Counts and Values in WUI Intermix Areas

Knox County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	23,801	325	141	7,298	203	148	9	674	**32,599**
Cost of Building	$3,343,389,500	$114,954,000	$53,908,500	$154,473,200	$21,058,500	$1,714,400	$802,800	$17,338,200	**$3,707,639,100**
Acres	61,072	1,553	1,436	70,654	713	3,914	174	2,090	**141,607**

City of Knoxville	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	7,744	135	42	2,306	58	98	3	189	**10,575**
Cost of Building	$1,240,287,800	$67,209,800	$4,755,800	$32,752,400	$13,652,100	$1,154,80 0	$334,600	$1,523,000	**$1,361,670,300**
Acres	12,453	581	199	11,299	250	2,240	133	409	**27,565**

Town of Farragut	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	200	-	4	91	-	-	1	12	**308**
Cost of Building	$51,770,800	$ -	$ -	$3,822,900	$ -	$ -	$193,500	$ -	**$55,787,200**
Acres	409	0	39	1,057	0	0	4	87	**1,594**

Table 3.58 Building Counts and Values in WUI Interface Areas

Knox County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	25,438	530	118	4,192	175	191	9	409	**31,062**
Cost of Building	$3,137,322,400	$168,822,100	$98,745,800	$89,887,800	$13,733,400	$6,356,400	$2,780,900	$29,363,200	**$3,547,012,000**
Acres	28,601	1,202	1,246	35,107	590	3,865	55	1,342	**72,009**

City of Knoxville	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	7,533	267	62	1,193	65	123	2	80	**9,325**
Cost of Building	$826,548,900	$103,761,300	$63,919,800	$8,793,600	$2,310,600	$3,201,000	$69,900	$4,276,900	**$1,012,882,000**
Acres	4,984	582	414	37,139	170	1,963	4	160	**45,417**

Town of Farragut	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	TOTAL
Number of Buildings	0	0	0	0	0	0	0	0	**0**
Cost of Building	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	**$ -**
Acres	0	0	0	0	0	0	0	0	**0**

Table 3.59 Number of Critical Facilities within Interface/Intermix Areas

Critical Facility	Nursing Home	Community Service	Daycare	Emergency	Government	Health Service	School
Wildland Urban Interface Area							
Knox County (unincorporated)	3	7	14	6	0	1	9
City of Knoxville	2	2	6	2	2	4	4
Town of Farragut	0	0	0	0	0	0	0
Total	**5**	**9**	**20**	**8**	**2**	**5**	**13**
Wildland Urban Intermix Area							
Knox County (unincorporated)	0	3	6	5	1	0	7
City of Knoxville	0	1	7	2	1	1	6
Town of Farragut	0	0	1	0	0	0	1
Total	**0**	**4**	**14**	**7**	**2**	**1**	**14**

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. The three main dangers that the elderly face each winter are: slip-and-fall accidents with resulting fractures and other injuries; hypothermia, which greatly increases the chances of heart attacks and strokes; and being stranded alone after a heavy snowstorm.

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 3.60 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 3.60 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 3.61 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 3.61 Loss of Use Estimates for Power Failure Associated with Severe Winter Storms

Jurisdiction	Population (2016)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
Knox County (unincorporated)	247,611	24,761	$3,119,899
City of Knoxville	186,239	18,624	$2,346,611
Town of Farragut	22,282	2,228	$280,753

Total	456,132	45,613	$5,747,263

Property Losses

According to reports from the NCDC, there were 39 occurrences of winter storms in the planning area and total reported property damages of $846,337 during the 24-year period from 1993 to 2017. This computes to an average annual property loss of $35,264.

Increase Risk Populations

Elderly populations are considered to be at increased risk to Winter Storms. Table 3.62 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 3.62 Number and Percent of Population Over Age 65 in Knox County

Jurisdiction	Population Over 65	% of Population Over 65
Knox County (unincorporated)	33,714	13.5
City of Knoxville	25,263	13.5
Town of Farragut	3,676	17.2
Total Knox County	62,653	14.1

Source: 2015 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 3.63 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 2010 to 2015. With 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 3.63 Change in Population and Housing Units

Location	2010 Population	2015 Population	Percent Change 2010-2015	2010 Housing Units	2015 Housing Units	Percent Change 2010 - 2015
Knox County (unincorporated)	237,660	248,520	4.6	96,555	100,258	3.8
City of Knoxville	173,890	186,238	7.1	90,812	89,955	-0.94
Town of Farragut	20,676	21,374	3.4	7,582	7,906	4.3

Source: U.S. Census Bureau;

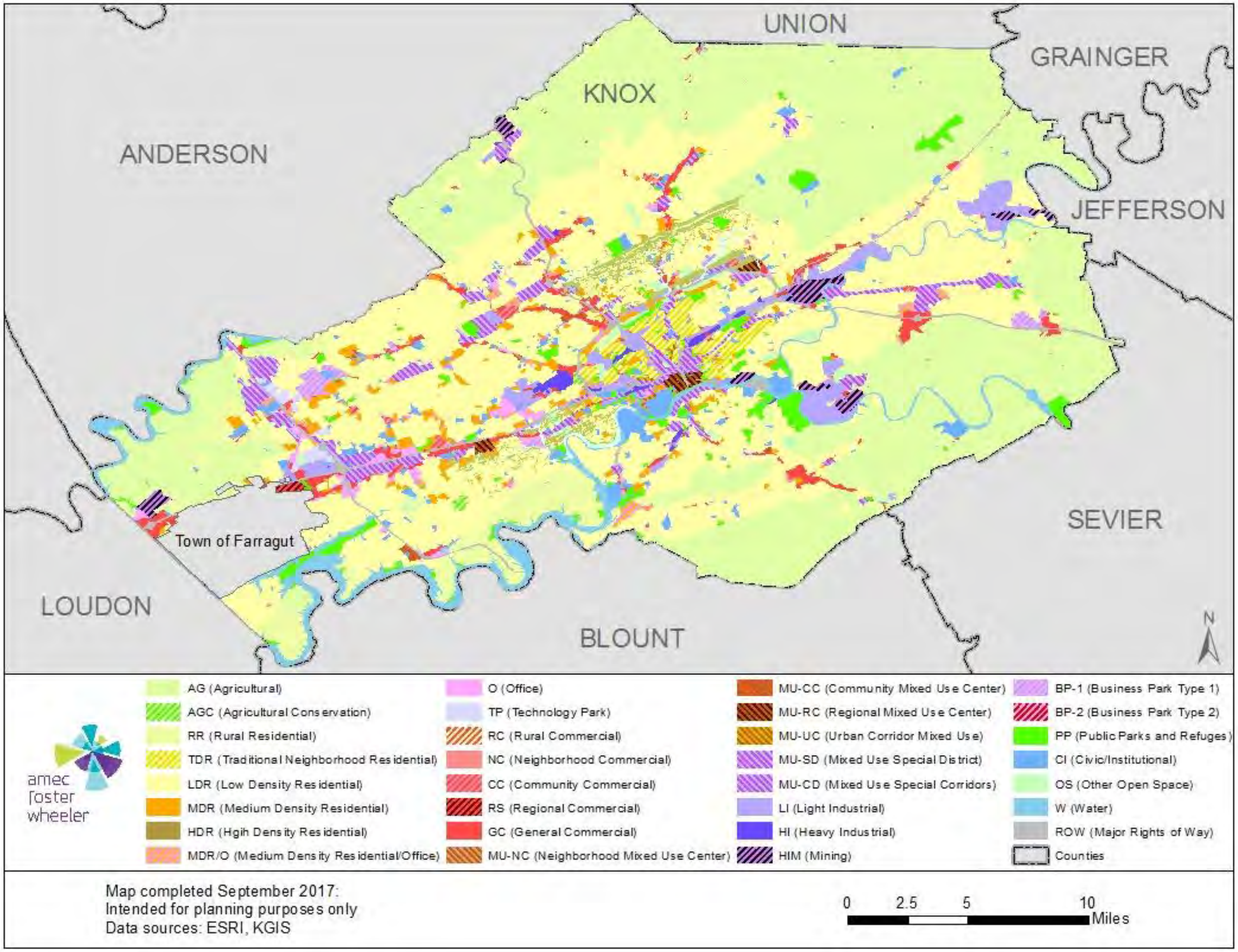
Planned Development/Expansion Activities

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 3.70 shows the planned future growth for the City and County.

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.

Figure 3.70. Future Land Use for Knoxville-Knox County



3.3.5 Summary of Key Issues

Table 3.64 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 3.64 Knox County Hazard Ranking-High to Low Planning Significance

Hazard	Knox County	City of Knoxville	Town of Farragut
Extreme Temperatures	3.10 - H	3.10 - H	3.10 - H
Flood	3.10 - H	3.10 - H	1.90 - L
Severe Storms	3.10 - H	3.10 - H	3.10 - H
Land subsidence & sinkholes	2.90 - M	2.90 - M	2.25 - M
Winter Storm	2.75 - M	2.75 - M	2.75 - M
Tornadoes	2.25 - M	2.25 - M	2.25 - M
Wildfires	2.35 - M	2.35 - M	2.35 - M
Landslides	2.45 - M	2.45 - M	1.80 - L
Earthquake	1.85 - L	1.85 - L	1.85 - L
Drought	1.80 - L	1.80 - L	1.80 - L
Dam Failure	1.55 - L	1.55 - L	1.00 - L
Expansive Soils	1.00 - L	1.00 - L	1.00 - L

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

Extreme Temperatures

- Persons over 65 and under 5 years old are especially vulnerable.
- Persons with limited financial resources (such as those households with incomes below the 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 17.2 percent. The City of Knoxville has the highest percentage of residents under 5, at 5.9 percent, and the City of Knoxville has the highest percentage of population below the poverty level, at 25.7 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.
- The Knoxville-Knox County Emergency Management Agency published in 2017 an Excessive Heat Plan to establish procedures to coordinate local government agencies, news broadcast companies, public utilities and volunteer agencies in response to excessive heat events (EHE's) 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. There are 18 properties in the unincorporated county, 36 in City of Knoxville, and one in the Town of Farragut.
- Flashflooding occurs repeatedly in some known areas, often outside of the mapped floodplain.
- Sinkhole Flooding occurs within the planning area.
- 1-percent annual chance flood event could damage 575 buildings at cost of $162M and displace approximately 8,892 residents. The use of the updated DFIRM data in conjunction with HAZUS-MH MR4 showed an decrease in the number of vulnerable structures.
- There are 1,042 flood insurance policies in force with approximately $300 million in coverage.
- $20,256 annualized losses to crops due to flooding and excessive moisture.
- 83% of field crops are insured.
- Eleven Critical Facilities are located within the Floodplain – four within the unincorporated areas of Knox County and seven within the City of Knoxville.

Severe Storms

- Manufactured homes, campers and light buildings at increased risk of damages.
- There are 9,992 manufactured homes in the planning area, most in unincorporated areas.
- Causes power outages from downed power lines.
- Annualized losses estimated at $115,882 based on NCDC historical accounts.

Land Subsidence & sinkholes

- 15 percent of City of Knoxville is built around or in sinkholes.
- The Knox County Stormwater Management Manual for contains polices/regulations for developments near sinkholes.
- The Town of Farragut regulates development in hazardous area through a local sinkhole ordinance.

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 $5.7 million in damages per day.
- NCDC annualized losses are $35,264.

Tornado

- There are 9,992 manufactured homes in the planning area, most in unincorporated areas.
- A .0653 square mile tornado path could impact an estimated 12 homes in unincorporated county, 56 in City of Knoxville, and 32 in Town of Farragut.

Wildfire

- From 2011-2016, Knox County had 129 forest/woods/wildland fires that burned 351 acres.
- Areas most vulnerable are agricultural areas where land is burned, rural areas where trash is burned, and wildland-urban interface areas.

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.
- The Knoxville-Knox County Hillside and Ridgetop Protection Plan provides direction to safely development steep slopes and ridgetops within the community while minimizing offsite environmental damage. The plan recognizes that implementation of the general objectives depends upon future adoption of ordinances and regulations by the legislative bodies of the City and County governments.

Earthquake

- Knox County experiences frequent low-magnitude events.
- 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.

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 $1,068 from 2007-2016.

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.

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 the March 2013 *Local Mitigation Planning Handbook*:

- **Goals** are general guidelines that explain what the community wants to achieve with the plan. They are usually broad policy-type statements that are long-term, and they represent visions for reducing or avoiding losses from the identified hazards.
- **Mitigation Actions** are specific actions that help achieve goals.

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 the planning area. 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, 2013. 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. Strengthen protection of critical facilities and infrastructure from natural hazards to create a safer, more sustainable community.

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 Foster Wheeler provided the HMPC with information on 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.

The HMPC then analyzed a list of potential structural and nonstructural mitigation alternatives, which were organized by hazard and based upon the risk assessment, existing capabilities, and plan goals and objectives. Through a facilitated planning process, each committee member developed ideas for mitigation actions based upon these alternatives and their own ideas. Duplicate ideas were condensed to a refined list of mitigation actions that were written on index cards and categorized by mitigation action type.

Some alternatives identified did not make it to this refined list because they were determined by the HMPC to not be politically, technically, or financially feasible or because no champion for the action was present in the group. However, these ideas are still captured in Appendix C and may be readdressed if funding opportunities change or during the next plan update process.

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.

Each proposed mitigation action was evaluated against the following considerations:

- Compatibility with goals and objectives identified in the current Tennessee Hazard Mitigation Plan (2013);
- Assessment of the impact of identified actions on Knox County, the City of Knoxville, and the Town of Farragut; and
- Compatibility with other local and regional plans and programs.

To prioritize the mitigation actions, each participating HMPC member evaluated the actions using a simple cost/benefit analysis (Table 4.1). Presented as a web-based survey, HMPC members rated each mitigation action for both benefit (low, medium, or high) and funding impact (easy, potential, or difficult). A weighted score was then applied to the total number of votes within each cost/benefit category for a total priority score. A scoring example is presented in Table 4.2. Depending on the results of the action evaluations, each action is recognized as a high priority project (60 to 100 points), medium priority project (50-59 points), or low priority project (0 to 49 points). The results of the prioritization process are included in Tables 4.3 and 4.4. Figure 4.1 presents a sample of the web-based survey.

This process of identification and analysis of mitigation options allowed the HMPC to come to consensus and to prioritize recommended mitigation actions. Emphasis was placed on the importance of a cost-benefit analysis in determining project priority; however, this was not a quantitative analysis. 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 intends to pursue implementation according to when and where damage occurs, available funding, political will, local priority, and priorities identified in the Tennessee Hazard Mitigation Plan. Cost-effectiveness will be considered in additional detail when seeking FEMA mitigation grant funding for eligible projects identified in this plan.

Table 4.3 summarizes identified actions and provides information on the hazards addressed and plan goals achieved. The individual action items, as recommended and prioritized by the HMPC, are then presented in order of priority. Each action item includes responsible office, potential funding, timeline, and estimated cost level for each identified action. Each mitigation action is also identified as either corrective or preventative. Corrective mitigation actions are focused on correcting past practices that have increased hazard vulnerability. These actions address existing buildings and infrastructure. Preventative mitigation actions prevent future problems from occurring in the first place through public education and outreach, informed decision-making and disaster resistant building/development practices. These actions address future buildings and infrastructure. Completed action items, as noted in Table 4.3 are presented in Appendix C.

Table 4.1 Benefit/Cost Analysis

Benefit	Definition	Weighted Value
Low	Difficult to assess benefits of this action; long-term time-frame for implementation	1
Medium	Long-term impact on reduction of losses is anticipated; implementation within 5 years	2
High	Meaningful impact on reduction of losses; implementation within 5 years is important	3
Cost	**Definition**	**Weighted Value**
Difficult to Fund	Funding sources not secured; grant funding will be needed	1
Potential to Fund	Funding requires budgeting over multiple years; grant funding potential	2
Easily Funded	Funds to implement action are available in existing budget	3

Table 4.2 Example Mitigation Action Prioritization

Action: Prioritize and secure funding for buyout of repetitive flood properties.

Benefit	HMPC Votes	Weighted Value	Score
Low	0	1	0
Med	3	2	6
High	10	3	30
Cost	**Definition**	**Weighted Value**	**Score**
Difficult to Fund	0	1	0
Potential to Fund	2	2	4
Easily Funded	11	3	33
TOTAL SCORE			**73 - HIGH**

Figure 4.1 Mitigation Action Survey

Knox County, City of Knoxville, and Town of Farragut - Hazard Mitigation Actions

Prioritization of Mitigation Actions

At the last mitigation planning meeting, multiple NEW mitigation actions were identified to reduce the impacts of the natural hazards identified in our risk assessment. The next step is to prioritize the mitigation actions for implementation. We ask for your input to prioritize the mitigation actions using a benefit/cost analysis. Please rank each mitigation action based upon BOTH benefit (low/med/high) and funding impact (low/med/high).

1. Amplify outreach/public education to encourage participation in Reverse 911 system.

- ☐ **LOW BENEFIT**: Difficult to assess benefits of this action; long-term time-frame for implementation
- ☐ **MEDIUM BENEFIT**: Long-term impact on reduction of losses is anticipated; implementation within 5 years
- ☐ **HIGH BENEFIT**: Meaningful impact on reduction of losses; implementation within 5 years is important
- ☐ **LOW COST**: Easily Funded! Funds to implement action are available in existing budget
- ☐ **MEDIUM COST**: Potential to Fund; Funding requires budgeting over multiple years; grant funding potential
- ☐ **HIGH COST**: Difficult to Fund; Funding sources not secured; grant funding will be needed

2. Create and/or update existing KEMA fact sheets for natural hazards to define hazard risks and suggest personal mitigation actions.

- ☐ **LOW BENEFIT**: Difficult to assess benefits of this action; long-term time-frame for implementation
- ☐ **MEDIUM BENEFIT**: Long-term impact on reduction of losses is anticipated; implementation within 5 years
- ☐ **HIGH BENEFIT**: Meaningful impact on reduction of losses; implementation within 5 years is important
- ☐ **LOW COST**: Easily Funded! Funds to implement action are available in existing budget
- ☐ **MEDIUM COST**: Potential to Fund; Funding requires budgeting over multiple years; grant funding potential
- ☐ **HIGH COST**: Difficult to Fund; Funding sources not secured; grant funding will be needed

3. Provide educational workshop and/or informational materials for the real estate industry including buyers, agents, and lenders.

In addition to prioritization of the mitigation actions by the HMPC, the public was invited to an Open House at the Public Works Service Building to review the proposed mitigation actions, vote on priority actions, and provide input on additional mitigation actions (see Figure 4.2).

The following actions received the strongest interest of the public:

- Develop outreach/public education programs to address excessive heat, sheltering options, and information on reducing agricultural losses

- Research options to increase funding for home weatherization, with priority on assisting vulnerable populations through resources such as the Weatherization Assistance Program and the Knoxville-Knox County Community Action Committee.
- Ensure that hazard response plans reflect the needs of populations most vulnerable to those hazards, with a particular public interest on effective response to extreme heat.
- Research options for development BMPs to reduce urban heat island effect
- Enhance urban tree cover and promote greenspaces to improve stormwater management efforts and reduce urban heat island effects.
- Research options for requiring and enforcing the recommendations of the Hillside and Ridgetop Protection Plan.
- Pursue funding for back-up power generators for identified critical facilities and infrastructure.
- Implement Firewise program in areas identified at risk.
- Seek to identify and/or prioritize locations for community shelters for mobile home parks/manufactured housing. Secure funding for construction.
- Maintain up-to-date building codes with transition to 2018 ICC Code Suite

Figure 4.2 Public Open House

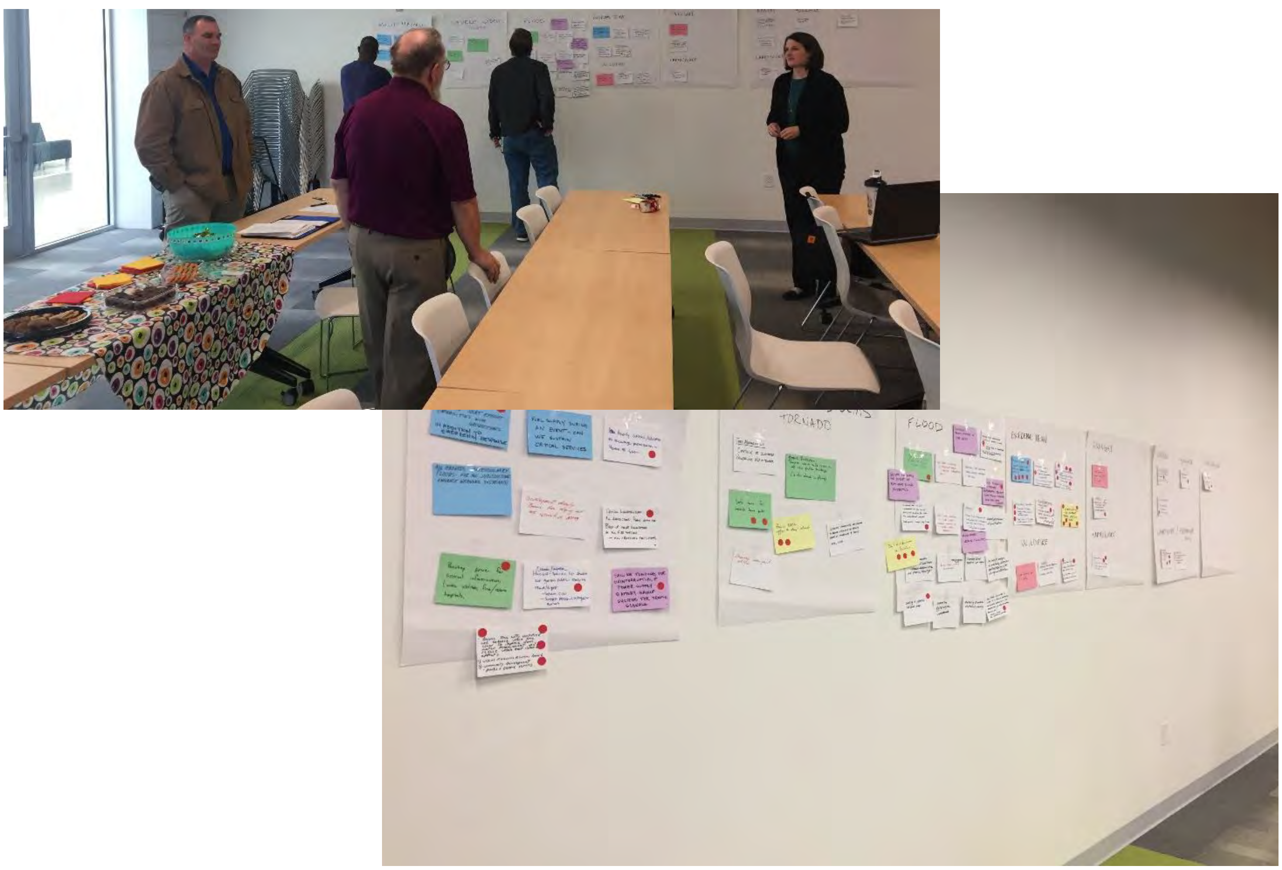


Table 4.3. Mitigation Action Matrix

Action	HMPC Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
Public Education						
1. Amplify outreach/public education to encourage participation in Reverse 911 system.	Medium	2	Multi-Hazard	✓		
2. Create and/or update existing KEMA fact sheets for natural hazards to define hazard risks and suggest personal mitigation actions.	Medium	2	Multi-Hazard	✓		
3. Provide educational workshop and/or informational materials for the real estate industry including buyers, agents, and lenders.	Medium	2	Multi-Hazard	✓		✓
4. Real estate disclosure to buyer of drainage easement maintenance responsibility. (Also, detention ponds, low impact development practices, etc.) Realtors Board, all governing agencies	High	2	Flood	✓		✓
5. Develop outreach/public education program to address excessive heat, sheltering options, and information on reducing agricultural losses	High	2	Extreme Temperature Drought	✓		
6. Develop outreach/public education program for defensible space for wildfire	Medium	2	Wildfire	✓		
Emergency Services						
7. Pursue funding for back-up power generators for identified critical facilities and infrastructure.	Medium	3	Multi-Hazard	✓		
8. Develop MOU for sharing community resources, in addition existing emergency response resources and capabilities.	High	1	Multi-Hazard	✓		

Action	HMPC Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
9. Review fuel supply and storage capabilities at critical facilities to ensure continuity of operations during a hazard event.	Medium	3	Multi-Hazard	✓		
10. Review potential for enhancement to existing warning system(s); identify methods for targeting vulnerable populations	Medium	1	Multi-Hazard, Floods	✓		
11. Secure funding for uninterruptible power supply battery-backup systems for traffic signals	Low	1	Multi-Hazard	✓		
Prevention						
12. Implement and Maintain the Knoxville-Knox County Excessive Heat Plan seeking partners to add/refine response options and incorporating public comment and participation	Medium	1	Extreme Temperature	✓	✓	
13. Encourage underground utilities for new development and as a retrofit for redevelopment.	Medium	1	Severe Storms, Tornado		✓	
14. Continue participation in the National Flood Insurance Program (NFIP)	Medium	1	Flood	✓	✓	✓
15. Participate in the NIFP Community Rating System (CRS) users group, seeking continued improvement in CRS rating	Medium	1	Flood	✓	✓	✓
16. Review opportunities to regulate private maintenance of stormwater systems conveyance and storage	Medium	1	Flood	✓	✓	✓
17. Research options to develop open space preservation policy, especially in streamside areas	Medium	1	Flood Extreme Temperature	✓	✓	✓

Action	HMPC Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
18. Research opportunities to implement more stringent requirements for low-impact development practices for new and redevelopment projects	High	1	Flood		✓	✓
19. Develop prioritization strategy for performing watershed assessments	Medium	1	Flood	✓	✓	✓
20. Research potential for including additional departments/disciplines in the development review process, such as stream determination, historic flooding, soil scientist, geologist/sinkhole review, and environmental review standards	High	1	Flood Expansive Soils		✓	✓
21. Research options for development BMPs to reduce urban heat island effect	High	1	Extreme Temperature	✓	✓	
22. Create a potential wetlands map	Medium	1	Flood		✓	
23. Maintain stormwater infrastructure mapping in coordination with neighboring jurisdictions	Medium	1	Flood	✓	✓	✓
24. Expand the Environmental Stewardship Program (ESP)	Medium	1	Flood	✓	✓	✓
25. Implement Firewise program in areas identified at risk.	High	1	Wildfire	✓	✓	
26. Create incentives to correct water utilities for drought	Low	1	Drought	✓	✓	
27. Develop sinkhole mapping using LiDAR	Medium	1	Sinkhole	✓	✓	✓
28. Research options for requiring and enforcing the recommendations of the Hillside and Ridgetop Protection Plan.	High	1	Landslide	✓	✓	

Action	HMPC Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
Property Protection						
29. Increase powerline maintenance to reduce instances of falling trees on powerlines and poles.	Low	1	Severe Storms, Tornado	✓		
30. Research regulations and process to require storm saferoom construction in all new public buildings	Low	3	Severe Storms, Tornado		✓	
31. Seek to identify and/or prioritize locations for community shelters for mobile home parks/manufactured housing. Secure funding for construction.	Medium	1	Severe Storms, Tornado	✓		
32. Continue roadway ditch maintenance to reduce roadway flooding, i.e. Concord Park on Northshore Drive.	High	1	Flood	✓		✓
33. Prioritize and secure funding for buyout of repetitive flood properties	Low	1	Flood	✓		✓
34. Secure funding for protection and/or relocation of flood-prone critical facilities	Low	3	Flood	✓		✓
35. Develop pro-active stormwater and/or public works maintenance program for stormwater infrastructure, including preventative culvert inspections and repair	Medium	1	Flood	✓		✓
36. Research options to increase funding for home weatherization, with priority of vulnerable populations	High	1	Extreme Temperature	✓		
37. Maintain up-to-date building codes with transition to 2018 ICC Code Suite	High	1	Multi-Hazard; Extreme Temperature	✓	✓	✓

Action	HMPC Priority	Goals Addressed	Hazards Addressed	Address Current Development	Address Future Development	Continued Compliance with NFIP
Natural Resources Protection						
38. Research potential to provide incentives for development outside of environmentally sensitive areas	Medium	1	Multi-Hazard		✓	✓
39. Enhance urban tree cover and promote greenspaces to improve stormwater management efforts and reduce urban heat island effects.	High	1	Multi-Hazard	✓	✓	
Structural Projects						
40. Secure funding for roadway improvement projects that protect roadways from repetitive flooding	Medium	3	Flood	✓	✓	✓
41. First Creek Improvements – 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.	Low	1	Flood	✓	✓	✓
42. Replacement of undersized stormwater drainage pipes as identified through flash flooding events, local drainage complaints, and future watershed studies.	Medium	1	Flood	✓	✓	✓

Table 4.4. Mitigation Action Implementation Strategy

Action ID	HMPC Priority	Mitigation Action	Mitigation Category	Responsible Office	Partners	Potential Resources/Funding	Estimated Cost Level	Timeframe	Status
Multi-Jurisdictional									
1	Medium	Amplify outreach/public education to encourage participation in Reverse 911 system.	• Public Education	• KEMA	• Public Information Officers	Existing Budget/Manpower	Low	Within 1 to 3 years	New
2	Medium	Create and/or update existing KEMA fact sheets for natural hazards to define hazard risks and suggest personal mitigation actions.	• Public Education	• KEMA	• Public Information Officers	Existing Budget/Manpower	Low to Medium	Within 1 to 3 years	New
3	Medium	Provide educational workshop and/or informational materials for the real estate industry including buyers, agents, and lenders.	• Public Education	• Engineering • Community Development	• Public Information Officers		Low to Medium	Within 1 to 3 years	New
4	High	Real estate disclosure to buyer of drainage easement maintenance responsibility. (Also, detention ponds, low impact development practices, etc.) Realtors Board, all governing agencies	• Public Education	• Engineering • Community Development	• Public Information Officers		Medium	Within 3 to 5 years	New
7	Medium	Pursue funding for back-up power generators for identified critical facilities and infrastructure.	• Emergency Services	• KEMA		Existing Budget; FEMA Hazard Mitigation Assistance (HMA) grant funding	Low to Medium	Within 3 to 5 years	Updated from 2011 Plan
8	High	Develop MOU for sharing community resources, in addition existing emergency response resources and capabilities.	• Emergency Services	• KEMA		Existing Budget/Manpower	Low	Within 1 to 3 years	New
9	Medium	Review fuel supply and storage capabilities at critical facilities to ensure continuity of operations during a hazard event.	• Emergency Services	• KEMA		Existing Budget/Manpower	Low to Medium	Within 1 to 3 years	New
10	Medium	Review potential for enhancement to existing warning system(s); identify methods for targeting vulnerable populations	• Emergency Services	• KEMA		Existing Budget; Department of Homeland Security (DHS) grant funding	Low to Medium	Within 3 to 5 years	New
11	Low	Secure funding for uninterruptible power supply battery-backup systems for traffic signals	• Emergency Services	• Transportation	• KEMA	Existing Budget; Department of Homeland Security (DHS) grant funding	Medium to High	Over 5 years	Updated from 2011 Plan
12	Medium	Implement and Maintain the Knoxville-Knox County Excessive Heat Plan seeking partners to add/refine response options and incorporating public comment and participation	• Prevention	• KEMA		Existing Budget/Manpower	Low to Medium	Within 1 to 3 years	New
13	Medium	Encourage underground utilities for new development and as a retrofit for redevelopment.	• Prevention	• Engineering • Community Development		Existing Budget/Manpower	Low to Medium	Within 3 to 5 years	New
14	Medium	Continue participation in the National Flood Insurance Program (NFIP)	• Prevention	• Engineering		Existing Budget/Manpower	Low	Ongoing	Updated from 2011 Plan
15	Medium	Participate in the NIFP Community Rating System (CRS) users group, seeking continued improvement in CRS rating	• Prevention	• Engineering		Existing Budget/Manpower	Low to Medium	Within 1 to 3 years	New
16	Medium	Review opportunities to regulate private maintenance of stormwater systems conveyance and storage	• Prevention	• Engineering • Community Development		Existing Budget/Manpower	Medium	Over 5 years	New

Action ID	HMPC Priority	Mitigation Action	Mitigation Category	Responsible Office	Partners	Potential Resources/Funding	Estimated Cost Level	Timeframe	Status
17	Medium	Research options to develop open space preservation policy, especially in streamside areas	• Prevention	• Engineering • Community Development		Existing Budget/Manpower	Medium	Over 5 years	New
18	High	Research opportunities to implement more stringent requirements for low-impact development practices for new and redevelopment projects	• Prevention	• Engineering • Community Development		Existing Budget/Manpower	Medium	Over 5 years	New
19	Medium	Develop prioritization strategy for performing watershed assessments	• Prevention	• Engineering		Existing Budget/Manpower	Medium	Within 1 to 3 years	New
20	High	Research potential for including additional departments/disciplines in the development review process, such as stream determination, historic flooding, soil scientist, geologist/sinkhole review, and environmental review standards	• Prevention	• Engineering • Community Development		Existing Budget/Manpower	Medium	Over 5 years	New
21	High	Research options for development BMPs to reduce urban heat island effect	• Prevention	• Engineering • Community Development	• Sustainability • Urban Forestry	Existing Budget/EPA grant funding	Medium	Within 3 to 5 years	New
22	Medium	Create a potential wetlands map	• Prevention	• Engineering • GIS		Existing Budget/Manpower	Medium	Over 5 years	New
23	Medium	Maintain stormwater infrastructure mapping in coordination with neighboring jurisdictions	• Prevention	• GIS		Existing Budget/Manpower	Low to Medium	Within 1 to 3 years	New
24	Medium	Expand the Environmental Stewardship Program (ESP)	• Prevention	• Engineering		Existing Budget/Manpower	Medium	Over 5 years	New
25	High	Implement Firewise program in areas identified at risk.	• Prevention	• Rural Metro Fire • Fire Departments	• KEMA	Existing Budget/Manpower	Medium	Within 3 to 5 years	New
26	Low	Create incentives to correct water utilities for drought	• Prevention	• Engineering • KUB		Existing Budget/Manpower	Medium	Over 5 years	New
28	High	Research options for requiring and enforcing the recommendations of the Hillside and Ridgetop Protection Plan.	• Prevention	• Metropolitan Planning Commission • Engineering • Community Development		Existing Budget/Manpower	Medium	Within 1 to 3 years	New
29	Low	Increase powerline maintenance to reduce instances of falling trees on powerlines and poles.	• Property Protection	• KUB		Existing Budget/Manpower	Medium to High	Within 1 to 3 years	New
30	Low	Research regulations and process to require storm saferoom construction in all new public buildings	• Property Protection	• Engineering • Community Development		Existing Budget/Manpower	Medium	Over 5 years	Updated from 2011 Plan
31	Medium	Seek to identify and/or prioritize locations for community shelters for mobile home parks/manufactured housing. Secure funding for construction.	• Property Protection	• KEMA		Existing Budget/Manpower	Low to Medium	Within 3 to 5 years	New
33	Low	Prioritize and secure funding for buyout of repetitive flood properties	• Property Protection	• Engineering	• KEMA	Existing Budget; FEMA Hazard Mitigation Assistance (HMA) grant funding	Medium to High	Within 3 to 5 years	Updated from 2011 Plan

Action ID	HMPC Priority	Mitigation Action	Mitigation Category	Responsible Office	Partners	Potential Resources/Funding	Estimated Cost Level	Timeframe	Status
34	Low	Secure funding for protection and/or relocation of flood-prone critical facilities	• Property Protection	• Engineering	• KEMA	Existing Budget; FEMA Hazard Mitigation Assistance (HMA) grant funding	Medium to High	Over 5 years	Updated from 2011 Plan
35	Medium	Develop pro-active stormwater and/or public works maintenance program for stormwater infrastructure, including preventative culvert inspections and repair	• Property Protection	• Engineering • Public Works		Existing Budget/Manpower	Medium to High	Over 5 years	New
36	High	Research options to increase funding for home weatherization, with priority of vulnerable populations	• Property Protection	• Sustainability • Community Development	Knoxville-Knox County Community Action Committee	Existing Budget/Manpower	Medium	Within 3 to 5 years	New
38	Medium	Research potential to provide incentives for development outside of environmentally sensitive areas	• Natural Resource Protection	• Engineering • Community Development		Existing Budget/Manpower	Medium	Over 5 years	New
40	Medium	Secure funding for roadway improvement projects that protect roadways from repetitive flooding	• Structural Projects	• Engineering • Transportation		Existing Budget; FEMA Hazard Mitigation Assistance (HMA) grant funding	High	Over 5 years	Updated from 2011 Plan
City of Knoxville									
5	High	Develop outreach/public education program to address excessive heat, sheltering options, and information on reducing agricultural losses	• Public Education	• KEMA	• Public Information Officers	Existing Budget/Manpower	Medium	Within 1 to 3 years	Updated from 2011 Plan
32	High	Continue roadway ditch maintenance to reduce roadway flooding, i.e. Concord Park on Northshore Drive.	• Property Protection	• Engineering • Public Works		Existing Budget/Manpower	Medium to High	Within 1 to 3 years	New
37	High	Maintain up-to-date building codes with transition to 2018 ICC Code Suite	• Property Protection	• Plans Review & Inspections		Existing Budget/Manpower	Medium to High	Within 3 to 5 years	New
41	Low	First Creek Improvements – 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.	• Structural Projects	• Engineering		Existing Budget; FEMA Hazard Mitigation Assistance (HMA) grant funding	High	Within 3 to 5 years	Updated from 2011 Plan
Town of Farragut									
27	Medium	Develop sinkhole mapping using LiDAR	• Prevention	• GIS		Existing Budget/Manpower	Medium	Over 5 years	New
39	High	Enhance urban tree cover and promote greenspaces to improve stormwater management efforts and reduce urban heat island effects.	• Natural Resource Protection	• Engineering • Community Development		Existing Budget/Manpower	Medium to High	Within 3 to 5 years	New
42	Medium	Replacement of undersized stormwater drainage pipes as identified through flash flooding events, local drainage complaints, and future watershed studies.	• Structural Projects	• Engineering		Existing Budget; FEMA Hazard Mitigation Assistance (HMA) grant funding	High	Over 5 years	New
Knox County									
6	Medium	Develop outreach/public education program for defensible space for wildfire	• Public Education	• KEMA	• Public Information Officers	Existing Budget/Manpower	Medium	Within 1 to 3 years	Updated from 2011 Plan

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 Previous Efforts to Monitor, Evaluate, and Update the Plan

Since the approval of the *Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan* in 2011, the HMPC has demonstrated a commitment to monitoring, evaluating, and updating the plan with formal annual meetings. These annual meetings have consisted of the following:

- Summary review of the hazard mitigation plan;
- Discussion of hazard events over the previous year;
- Discussion of changes in development;
- Progress in mitigation efforts, including status updates to all mitigation actions in the previous plan;
- Discussion of available mitigation funding sources; and
- Discussion of continued public involvement.

Conducting in coordination with the annual CRS update, the Knox County Stormwater Department provided the updated Mitigation Strategy with the current status of each mitigation action to the Knox County Commission, as well as, City of Knoxville and Town of Farragut requesting that the mitigation strategy be incorporated, where appropriate in other planning mechanisms. In addition, a press release was issued providing information on the annual review meeting and the summary results of the progress in mitigation efforts.

5.2 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.

5.2.1 Hazard Mitigation Planning Committee

With adoption of this plan, the HMPC will continue to 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 encourage implementation of the plan by local partners 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.

5.2.2 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 coordination 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.

5.2.3 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).

The annual reviews and 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.
- As part of the annual review process, the Knox County Stormwater Department will provide the updated Mitigation Strategy with the current status of each mitigation action to the Knox County Commission, as well as, City of Knoxville and Town of Farragut requesting that the mitigation strategy be incorporated, where appropriate in other planning mechanisms.

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.

5.3 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.

Table 5.1 provides additional details on each jurisdiction regarding how the 2011 Local Hazard Mitigation Plan was integrated into existing planning mechanisms as well as the strategy going forward to integrate this plan update into existing planning mechanisms.

Table 5.1. Integration of Previous Plan and Strategies to Integrate Plan Update

Jurisdiction	Incorporation of 2011 Plan into Existing Planning Mechanisms	Integration Process for Plan Update
Knox County, TN	-Ordinance and Design Manuals addresses hazards identified in Risk Assessment -Hillside and Ridgetop Protection Plan addresses hazards identified in Risk Assessment -Stormwater Infrastructure projects and repairs are coordinated with identified Mitigation Actions -Development Plans Review considers floodplain areas	-Incorporate into annual emergency management training, planning, and purchasing plans -Integrate the Risk Assessment in future updates of the Comprehensive Emergency Operations Plan and Excessive Heat Plan -Seek additional funding sources for mitigation projects -Coordinate Capital Improvements Plan and Infrastructure Planning with Mitigation Strategy -Integrate in the Knoxville-Knox County General Plan, as updates occur

Jurisdiction	Incorporation of 2011 Plan into Existing Planning Mechanisms	Integration Process for Plan Update
City of Knoxville	-Ordinance and Design Manuals addresses hazards identified in Risk Assessment -Hillside and Ridgetop Protection Plan addresses hazards identified in Risk Assessment -Stormwater Infrastructure projects and repairs are coordinated with identified Mitigation Actions -Development Plans Review considers floodplain areas	-Incorporate into annual emergency management training, planning, and purchasing plans -Coordinate with Energy & Sustainability Initiative -Integrate the Risk Assessment in future updates of the Comprehensive Emergency Operations Plan and Excessive Heat Plan -Seek additional funding sources for mitigation projects -Coordinate Capital Improvements Plan and Infrastructure Planning with Mitigation Strategy -Integrate in the Knoxville-Knox County General Plan, as updates occur
Town of Farragut	-Local Ordinance addresses hazards, including sinkholes, identified in Risk Assessment -Development Plans Review considers floodplain areas	-Seek additional funding sources for mitigation projects -Integrate in the Comprehensive Land Use Plan, as updates occur
Knox County Schools	Not integrated in formal planning mechanisms	-Integrate into Master Plan and School Emergency Plan -Coordinate Capital Improvements Plan with Mitigation Strategy

5.2 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.

APPENDIX A
ADOPTION RESOLUTIONS

To be inserted upon approval by TEMA and FEMA Region IV.

APPENDIX B PLANNING PROCESS DOCUMENTATION

Hazard Mitigation Planning Committee (HMPC)

Name	Representing	Department
McGinley, David	City of Knoxville; Primary Jurisdictional Contact	Stormwater Engineering
Roberts, Eddy	Knox County; Primary Jurisdictional Contact	Engineering, Stormwater Management
Sparks, David	Town of Farragut; Primary Jurisdictional Contact	Engineering
Fregeolle, Derek	Knox County Schools; Primary Jurisdictional Contact	
Bonham, Zach	Town of Farragut	Community Development
Brink, Jimmy	KGIS	
Gill, Erin	City of Knoxville	Sustainability
Granju, Chris	Knox County	Engineering, Stormwater Management
Hagerman, David	City of Knoxville	Stormwater Engineering Plans Review
Harnish, Jerry	Rural Metro Fire	
Hatfield, Lisa	City of Knoxville	Law
Hathaway, Guy	American Red Cross	
Hixenbaugh, David	Knoxville Utilities Board (KUB)	
Hose, Bart	Town of Farragut	Community Development
Ickes, Colin	Knox EMA	
Kelly, Dan	MPC	
Knoefel, Erick	Rural Metro Fire	
Lilly, Randy	Knox County	Codes Administration and Enforcement
Mann, Amy	Knox County	Engineering, Stormwater Management
Napier, Todd	KCDC	
Nations, Dennis	Knox County	Codes Administration and Enforcement
Oglesby, Charissa	City of Knoxville	Engineering
Olsen, Cathy	Knox County	GIS
Roberts, Scott	Rural Metro Fire	
Saal, Lori	Town of Farragut	Stormwater Coordinator
Sexton, John	Knox County	Transportation
Shipley, Mark	Town of Farragut	Community Development
Stump, Keith	KGIS	
Wade, Becky	City of Knoxville	Community Development
Wasik, Judy	Knox EMA	
Weth, Chad	City of Knoxville	Public Works
Whitehead, Randall	City of Knoxville	
Woods, Brian	Rural Metro Fire	

Hazard Mitigation Planning Committee Meetings

- June 1, 2017 – Internal Coordination Meeting Handout
    - Conference Call with Amec Foster Wheeler and Knox County, City of Knoxville, and Town of Farragut
    - Introduction Flyer for HMPC
- July 11, 2017 – Kickoff Meeting Minutes
- September 26, 2017 – Risk Assessment Meeting Minutes
- October 25, 2017 – Mitigation Strategy Meeting Minutes

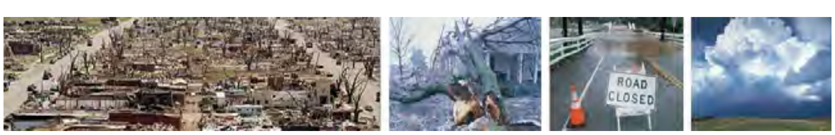
Public Involvement

- Public Outreach Plan
- Public Information Flyers #1
- Public Questionnaire
- Jurisdictional Websites
- September 26, 2017 – Public Meeting Presentation
    - Presentation and Sign-In Sheet
    - Resolution from NAACP, Knoxville TN Branch
- Stakeholders Mailing List, Template Letter
- October 25, 2017 – Open House Flyer
    - Sign-In Sheet
    - Photographs of event are included within Chapter 4, Mitigation Strategy
    - Updated Resolution from NAACP, Knoxville TN Branch
- Public Information Flyer #2 – TBD for Public Review of Draft
- Public Review of Draft Multi-Hazard Mitigation Plan - TBD

HMPC Planning Committee

The planning committee should include representatives from agencies involved in hazard mitigation activities, agencies with the authority to regulate development, and offices responsible for enforcing local ordinances. To best meet the DMA requirements and to facilitate plan development, we suggest representatives of the following organizations/departments be invited to participate in the HMPC and/or attend the meetings as an interested party:

Knox County and City of Knoxville Departments		Other Departments/Agencies
Knox County Code Administration	City of Knoxville Redevelopment	TEMA
Knox County Engineering/Stormwater	City of Knoxville Engineering	FEMA Region IV–Mitigation
Knox County Health Department	City of Knoxville Public Works	National Weather Service
Knox County Parks/Rec	City of Knoxville Parks/Rec	American Red Cross
Knox County Property Assessor	City of Knoxville Real Estate	U.S. Army Corps of Engineers
Knox County Public Library	City of Knoxville Fire Department	U.S. Forest Service
Knox County Rural/Metro Fire Department	City of Knoxville Community Development	U.S. Geological Services
Knox County Sheriff	School Districts*	
Knoxville-Knox County EMA	KUB*	
Knox County Development Corporation (KCDC)	First Utility District of Knox County	
Knox County GIS		
Knoxville-Knox County MPC		



Data Collection Needs

<u>General Mapping Data</u>
☐ ○ Base Map
☐ ○ Growth Maps
☐ ○ Land Use
☐ ○ Zoning
☐ ○ Population
☐ ○ Building Count & Value
☐ ○ Critical Facilities
☐ ○ Natural, Cultural, Historic Resources
☐ ○ Utility Infrastructure

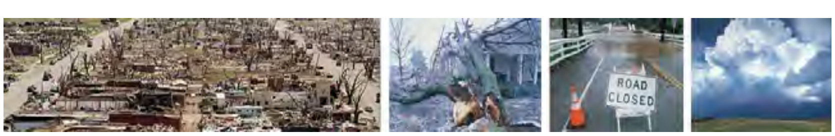
<u>Hazard Maps</u>
☐ ○ Floodplain (100 & 500 –year)
☐ ○ Wildfire (Hazard, Risk)
☐ ○ Landslide / Debris Flow
☐ ○ Steep Slopes
☐ ○ Wildland Urban Interface
☐ ○ Hazard Historic Events (wildfire, epicenters)
☐ ○High and Significant Hazard Dams
☐ ○ Levee Failure
☐ ○ Subsidence Areas – Coal Mines
☐ ○ Earthquake Shaking / Faults / Epicenters
☐ ○ Earthquake Liquefaction Potential
☐ ○ Earthquake Soil Amplification Potential
☐ ○ Hazardous Materials Fixed Facilities
☐ ○ Hazardous Materials Transmission Lines
☐ ○ Hazardous Materials Transport Routes
☐ ○ Repetitive Loss Structures (sensitive)

Critical Facilities

FEMA generally defines four kinds of critical facilities:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials
- Hospitals, nursing homes, and housing likely to have occupants who may not be sufficiently mobile to avoid injury or death during a hazard event
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for emergency response activities before, during, and after a hazard event
- Public and private utility facilities that are vital to maintaining or restoring normal services to hazard areas before, during, and after a hazard event

FEMA's HAZUS-MH loss estimation software uses the following three categories of critical assets. 'Essential facilities' are those that if damaged would have devastating impacts on disaster response and/or recovery. 'High potential loss facilities' are those that would have a high loss or impact on the



community. Transportation and lifeline facilities are third category of critical assets; examples are provided below.

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

FROM CURRENT 2011 PLAN

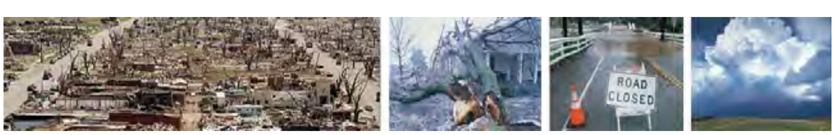
Table 3.34 is an inventory of critical facilities and infrastructure (based on available data) in the planning area.

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

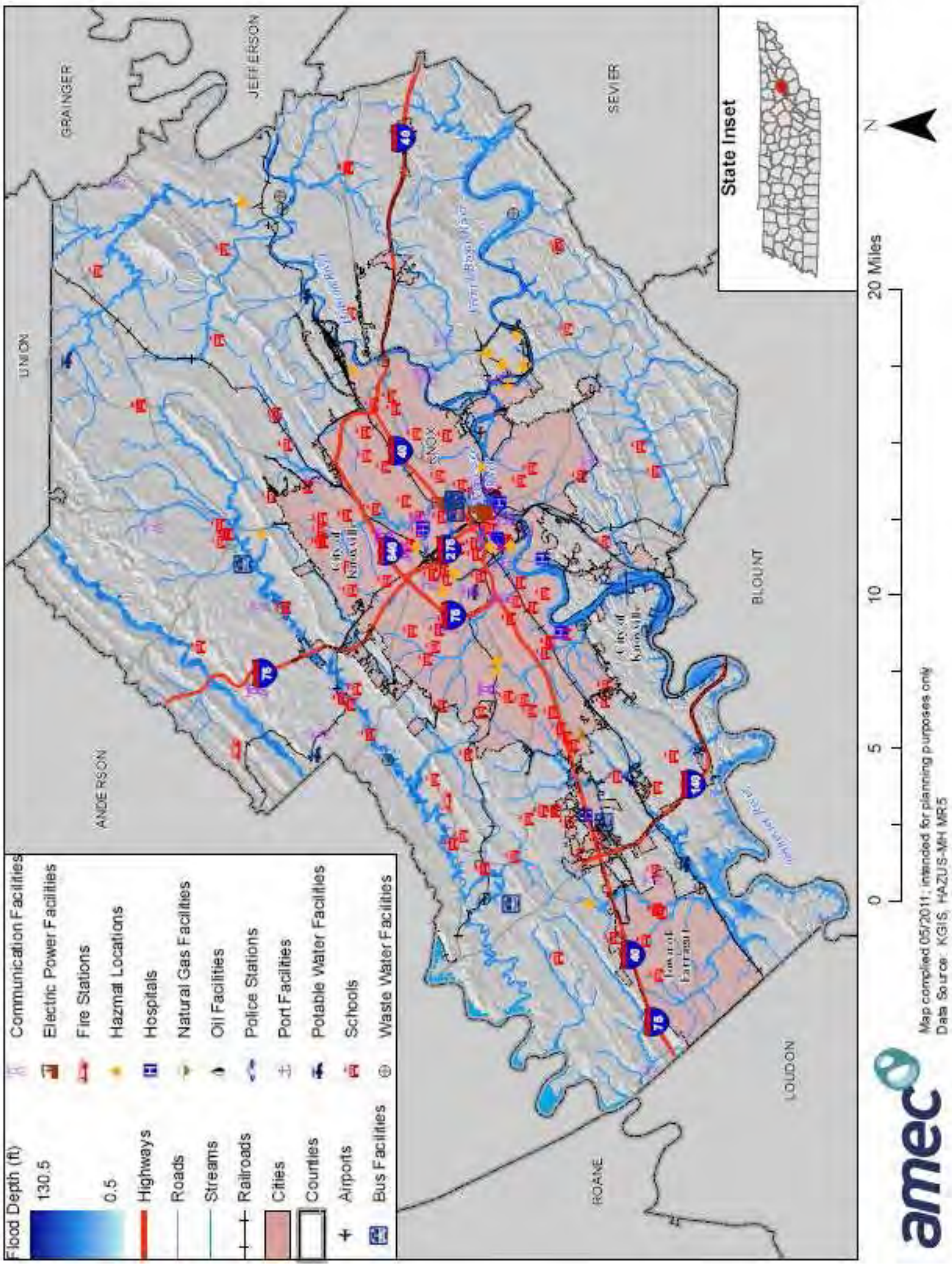


Figure 3.46 City of Knoxville Critical Facilities

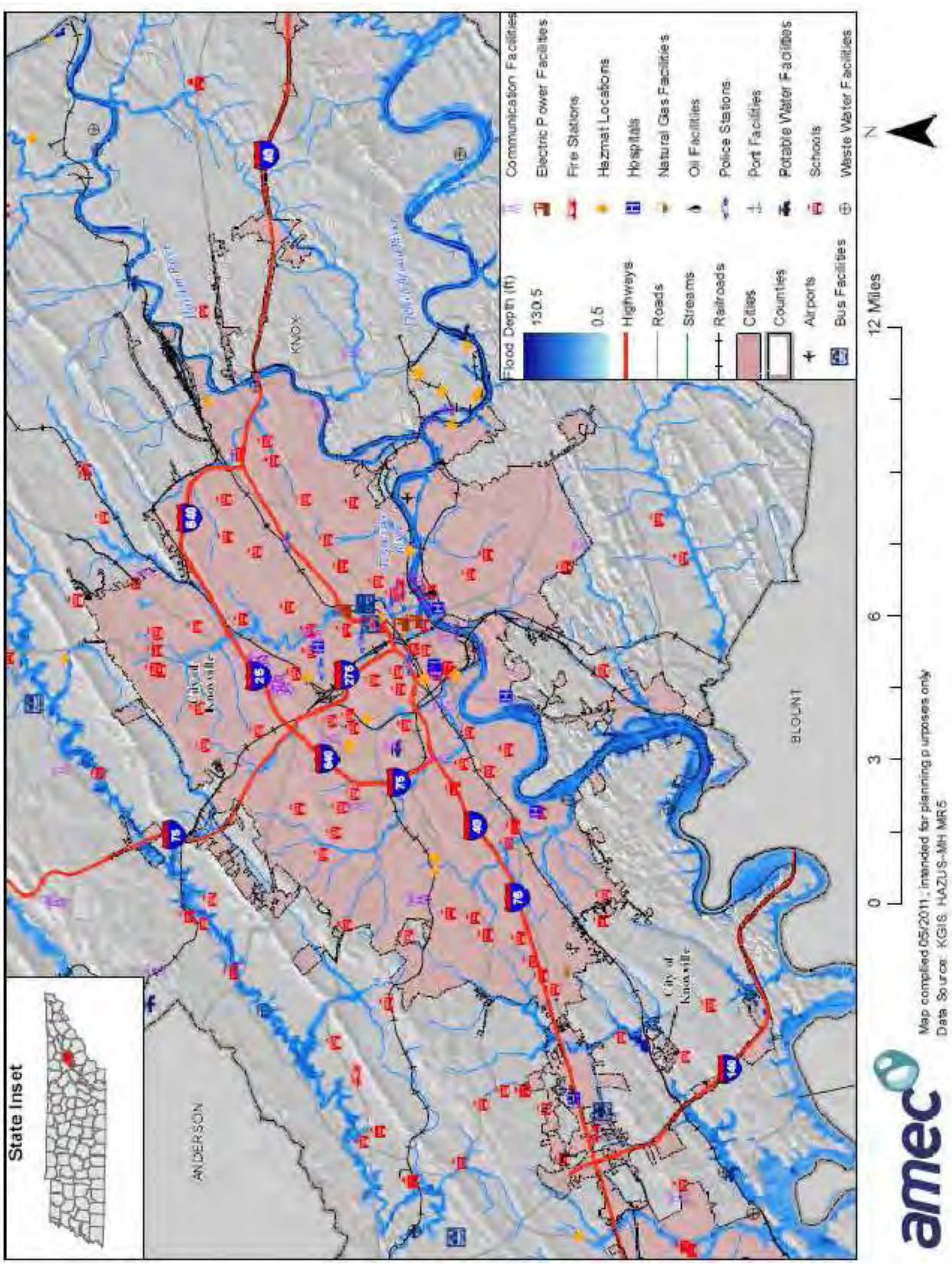
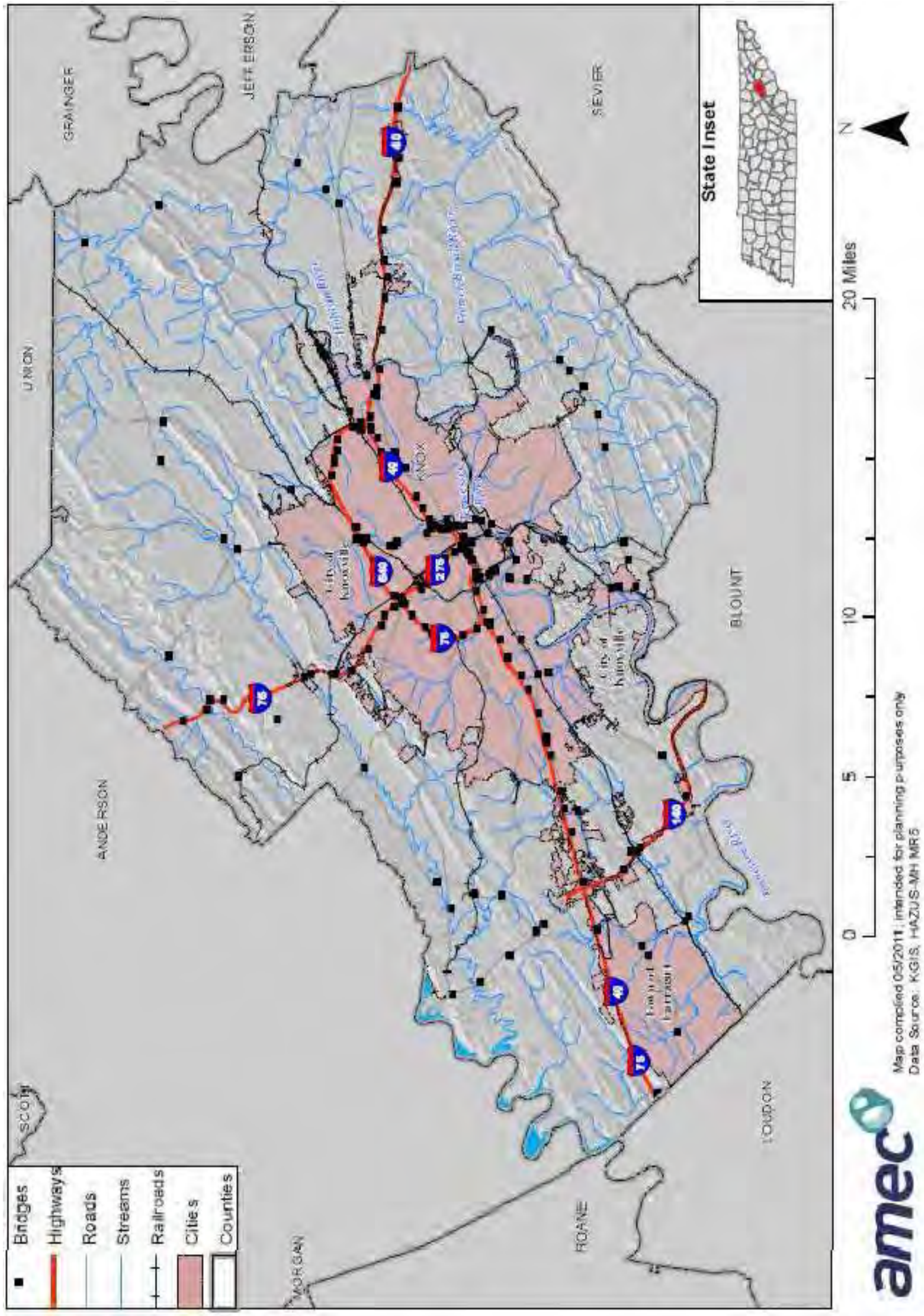
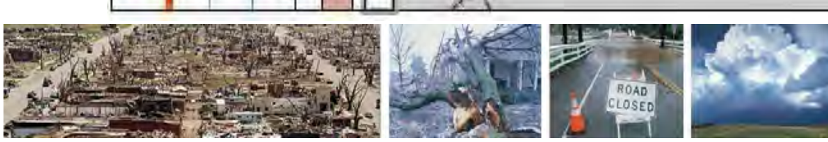


Figure 3.48 Knox County Bridges



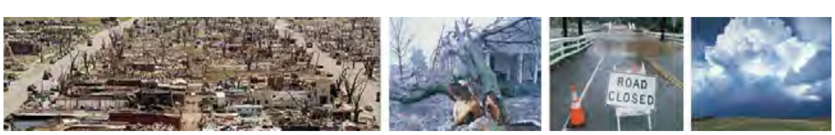


MITIGATION CAPABILITY ASSESSMENT

Regulatory

The following planning and land management tools are typically used by local jurisdictions to implement hazard mitigation activities. Please indicate which of the following your jurisdiction has in place. If your jurisdiction does not have this capability or authority, please indicate in the comments column if a higher level of government has the authority. Also use the comments column to indicate how we can obtain a copy of the plan or document (i.e. available on the web, will put on ftp, will email or mail).

Regulatory Tool (ordinances, codes, plans)	Y/N	Date	Comments
General plan	YES		Need to fill in details
Zoning ordinance	YES		Need to fill in details
Subdivision ordinance	YES		Need to fill in details
Growth management ordinance	YES		Need to fill in details
Floodplain ordinance	YES		Need to fill in details
Other special purpose ordinance (stormwater, steep slope, wildfire)			Need to fill in details
Building code	YES		Need to fill in details
BCEGS Rating	YES		3-Commercial and 4-Residentail
Fire department ISO rating	YES		Ratings:4-6 (varies across county)
Erosion or sediment control program	YES		Need to fill in details
Stormwater management program	YES		Need to fill in details
Site plan review requirements	YES		Need to fill in details
Capital improvements plan	YES		Need to fill in details
Economic development plan	YES		Need to fill in details
Local emergency operations plan	YES		Need to fill in details
Flood insurance study or other engineering study for streams	YES		Need to fill in details
Elevation certificates	YES		Need to fill in details



Administrative/Technical

Identify the technical and personnel resources responsible for activities related to hazard mitigation/loss prevention within your jurisdiction. For smaller jurisdictions without local staff resources, if there are public resources at the next higher level government that can provide technical assistance, please indicate so in the comments column.

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, Engineering & Public Works Dept., Stormwater Engineering Division
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
Other personnel		
GIS Data – Hazard areas	YES	Mitigation Plan; Not on KGIS
GIS Data - Critical facilities	YES	Mitigation Plan; Not on KGIS
GIS Data – Building footprints	YES	KGIS – footprints; parcels, pavement
GIS Data – Land use	YES	KGIS – Existing Landuse, Growth Plan, One-Year Plan; Zoning
GIS Data – Links to Assessor's data	YES	KGIS
Warning Systems/Services (Reverse 9-11, cable override,		



Personnel Resources	Yes/No	Department/Position
outdoor warning signals)		

Fiscal

Identify whether your jurisdiction has access to or is eligible to use the following financial resources for hazard mitigation

Financial Resources	Accessible/Eligible to Use (Y/N)	Comments
Community Development Block Grants	YES	
Capital improvements project funding	YES	
Authority to levy taxes for specific purposes	YES	
Fees for water, sewer, gas, or electric services	NO – Knox Co; YES – City of Knoxville	
Impact fees for new development	NO	
Incur debt through general obligation bonds	YES	
Incur debt through special tax bonds	YES	
Incur debt through private activities	YES	
Withhold spending in hazard prone areas	YES	
Other		

Knox County, Tennessee
Local Hazard Mitigation Plan Update

Overview

Knox County is beginning the process to update the Local Hazard Mitigation Plan to better protect the people and property of Knox County from the effects of natural hazard events. The plan will be updated 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. These regulations establish the requirements that hazard mitigation plans must meet in order for the County and participating jurisdictions 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). Because the County and participating jurisdictions are subject to many kinds of hazards, access to these federal programs is vital.

What is a Hazard Mitigation Plan?

A hazard mitigation plan is the result of a planning process which identifies policies and actions that can be implemented over the long term to reduce the risk and future losses resulting from hazard events. The Local Hazard Mitigation Plan will address a comprehensive list of natural hazards likely to impact the County and participating jurisdictions. The 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 figure to the right.

What is My Role in the Planning Process?

Knox County has contracted with Amec Foster Wheeler to facilitate the planning process and prepare the plan document. Amec Foster Wheeler's first tasks are to assist in reconvening the Hazard Mitigation Planning Committee (HMPC), as defined by the Disaster Mitigation Act (DMA), and begin preparations for a project kick-off meeting. The HMPC will include representatives from agencies involved in hazard mitigation activities, agencies with the authority to regulate development, and offices responsible for enforcing local ordinances. As a member of the HMPC, your participation in the planning process will include:

- Attending and contributing in the HMPC meetings;
- Providing requested data (as available);
- Reviewing and providing comments on plan drafts;
- Advertising, coordinating, and participating in the public input process; and



For additional information, please contact:
Eddy Roberts, Knox County Stormwater Department,
eddy.roberts@knoxcounty.org, (865) 215-5234

- Coordinating the formal adoption of the plan.

What can I expect for the HMPC Meetings?

In the coming months, Amec Foster Wheeler will facilitate three planning meetings with the HMPC, as briefly described below. Detailed agendas and information on the context of each meeting or activities performed within each meeting will be provided during the planning process.

- **Project Kick-off Meeting.** This meeting will initialize work with the HMPC. Amec Foster Wheeler will present information on federal planning requirements, participation requirements of HMPC members, and the proposed project work plan and schedule. A plan for public involvement and coordination with other agencies and departments will also be discussed at this initial meeting, especially regarding external agencies, such as state and federal agencies that may have significant interests (property, critical assets and infrastructure) in the County or that have information to help support the planning process. Amec Foster Wheeler will also provide follow-up interviews and data collection for development and jurisdiction profiles. Once the nucleus of the HMPC first meets at the Kickoff Meeting, it may be determined that additional representatives should be invited to participate.
- **Risk Assessment Meeting.** This meeting will include presentation of the risk assessment results and review/development of mitigation goals.
- **Mitigation Strategy Meeting.** This meeting will include updating of existing mitigation actions and identification and development of new mitigation strategies based upon the risk assessment.

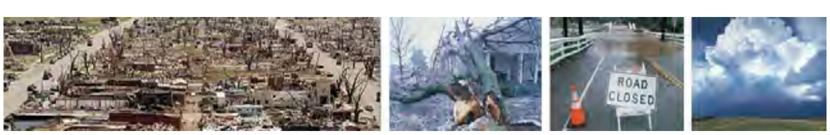
Additional Resources

The following links provide additional information on hazard mitigation and the planning process.

- **Knox County's current Local Hazard Mitigation Plan**
  https://www.knoxcounty.org/stormwater/pdfs/Hazard_Mitigation_Plan.pdf

- **The requirements and procedures for state, tribal and local mitigation plans as presented in the Code of Federal Regulations (CFR) at Title 44, Chapter 1, Part 201**
  https://www.fema.gov/media-library/assets/documents/15256

- **Frequently Asked Questions regarding hazard mitigation planning**
  https://www.fema.gov/hazard-mitigation-planning-frequently-asked-questions



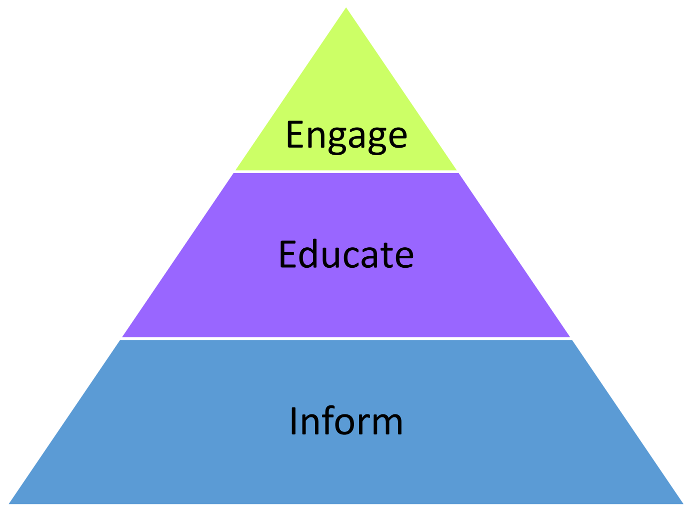
Knox County, City of Knoxville, Town of Farragut
Multi-Hazard Mitigation Plan Update

PUBLIC OUTREACH STRATEGY

The goal of this Public Outreach Strategy is to **engage, educate, and inform** the citizens of Knox County, the City of Knoxville, and Town of Farragut of local multi-hazard mitigation planning efforts to better protect the people and property of the communities from the effects of natural hazard events. Public involvement in the planning efforts is key in developing a plan that reflects the community's values and priorities, results in a greater success rate of mitigation action implementation, and ultimately creates a safer, more disaster-resilient community.

This Public Outreach Strategy identifies the outreach tools and activities for each of the major phases of the mitigation planning process which:

- **Engage** the public and other stakeholders through interactive dialogue including such forums as planning committee meetings, public meetings, workshops and open house events;
- **Educate** the public and other stakeholders through a listen and learn process such as neighborhood association presentations, information booths, and briefings to elected officials; and
- **Inform** the public and other stakeholders through one-way communication such as written outreach materials, websites, and news media.



ENGAGE

- **Participation on the Hazard Mitigation Planning Committee (HMPC) –** Representatives of the public and stakeholders of Knox County, the City of Knoxville, and Town of Farragut will be invited to participate on the HMPC. This may includes representation from: American Red Cross, Home Builders Associations, Farm Bureau, State NFIP Coordinator, etc.

- **Public Meetings -** Two (2) public meetings will be scheduled at key points in the project timeline to obtain public input on natural hazards, problems, and possible solutions. Meetings will be held at the completion of the draft risk and capability assessments and following development of mitigation actions. These meetings will be coordinated and arranged by Knox County, the City of Knoxville, and Town of Farragut with facilitation support from Amec Foster Wheeler.

For additional information, please contact:
Eddy Roberts, Knox County
Stormwater Department,
eddy.roberts@knoxcounty.org, (865) 215-5234

EDUCATE

- **Presentations for Stakeholder Groups –** Knox County, the City of Knoxville, and Town of Farragut staff will coordinate additional hazard mitigation presentations for various stakeholder groups to explain the planning process and encourage input to the HMPC. Identified stakeholder meetings include:
  - TBD
  - Neighborhood Meetings?

- **Briefings to Elected Officials –** Knox County, the City of Knoxville, and Town of Farragut staff will coordinate one-on-one meetings with County Board Representatives and/or elected officials, upon request, to provide updates on the mitigation planning process.

- **Questionnaire -** A public participation questionnaire will be prepared by Amec Foster Wheeler using the SurveyMonkey web hosting service and will be open to the public for two months. The purpose of this questionnaire is to solicit input from the public and stakeholders in Knox County, the City of Knoxville, and Town of Farragut staff regarding hazards of concern, areas of mitigation interest, and related preparedness. The online survey will give individuals that are unable to attend the in-person meetings the opportunity to participate in the planning process. The questionnaire will be made available through web links posted on the project information website, circulated via email, and social media outlets. Additionally, hard copies of the questionnaire will be distributed at all public meetings and presentations to stakeholders groups. The feedback received will be evaluated and incorporated into the Hazard Mitigation Planning Committee's decision making process and the final Multi-Hazard Mitigation Plan.

INFORM

- **Television and Newspaper Articles –** Through coordination with the community Public Information Officers, each HMPC and Public Meeting will be announced through press releases to generate interest and support from local television stations and newspapers.

- **Public Access Television –** Powerpoint presentations from the public meetings (2) will be presented on the local public access television channel to provide an overview of hazard mitigation planning and the planning process underway.

- **Website -** A project information website will be hosted by Knox County and will be available to the general public and to members of the Hazard Mitigation Planning Committee for the duration of the planning process with the primary purpose to share information relevant to the Multi-Hazard Mitigation Plan 2017 Update. Specific resources to be included on this site include:
  - Meeting schedule, agendas, presentations, and minutes;
  - Project information flyers (3) for introduction, risk assessment, and notification of draft document;
  - Link to online questionnaire



For additional information, please contact:
Eddy Roberts, Knox County
Stormwater Department,
eddy.roberts@knoxcounty.org, (865) 215-5234

- Draft Multi-Hazard Mitigation Plan for review/comment; and
- Reference documents and links to planning resources.

The website address is: https://www.knoxcounty.org/stormwater/fema_mitigation.php

- **Project Information Flyers –** Three (3) project information flyers will be developed and distributed throughout the planning process to provide information on the hazard mitigation planning and opportunities for public involvement. This resource will be available on the project information website as well as hard copies distributed to local libraries and public meetings identified in the 'educate' process. Specific information to be provided in the flyers includes:
  - What is a Hazard Mitigation Plan?
  - Why is it important to me?
  - What can I do to participate?
  - Planning Status
  - Mitigation Success Stories

- **Social Media –** Knox County, the City of Knoxville, and Town of Farragut County's social media outlets on Twitter and Facebook will be utilized to publish information regarding public meetings, the online questionnaire, and general hazard mitigation planning information.

Memorandum

To	**Knox County, City of Knoxville, and Town of Farragut Hazard Mitigation Planning Committee (HMPC)**
From	**Cindy Popplewell**
Tel / Email	**(615) 333-0630 / cindy.popplewell@amecfw.com**
Date	**September 26, 2017**
Subject	**Minutes from Multi-Hazard Mitigation Plan – Risk Assessment Meeting**

This memorandum presents the meeting minutes from the September 26, 2017, risk assessment meeting for the *Knox County, City of Knoxville, and Town of Farragut Multi-Hazard Mitigation Plan* Update. It provides an update on the planning progress and public survey results; a review of the hazard identification and risk assessment; and next steps. The PowerPoint presentation is included as Appendix A.

Attendees

Erick Knoefel, Rural Metro Fire
John Sexton, Knox County
Colin Ickes, KEMA
Cathy Olsen, GIS Admin
Lori Saal, Stormwater Coordinator
Chris Granju, Knox County Stormwater
Judy Wasik, KEMA
Chad Weth, City of Knoxville
Todd Napier, Development Corp of Knox Co
David Hixenbaugh, KUB
Jerry Harnish, Rural Metro Fire
Derek Fregeolle, Knox County Schools
Eddy Roberts, Knox County Engineering
David McGinley, City of Knoxville
Keith Stump, KGIS
Zach Banham, Town of Farragut
Bart Hose, Town of Farragut
Becky Wade, City of Knoxville
Erin Gill, City of Knoxville
Lisa Hatfield, City Lawyer
David Sparks, Town of Farragut
Dan Kelly, MPC
Cindy Popplewell, Amec Foster Wheeler

A copy of the sign-in sheet is included in Appendix B.

Introductions

The meeting began by welcoming and thanking the attendees and introductions all around.

Update on Hazard Mitigation Planning Progress

Amec Foster Wheeler's approach to the planning process is structured around FEMA's four-phase guidance for developing a hazard mitigation plan: 1) organize resources, 2) assess risks,

3) develop a mitigation plan, and 4) implement the plan and monitor progress. Amec Foster Wheeler integrates the nine planning tasks identified in FEMA's March 2013 Local Mitigation Planning Handbook into these four phases. As demonstrated in the table below, the planning tasks are also consistent with FEMA's Flood Mitigation Assistance (FMA) and Community Rating System (CRS) planning process, and will thus position Knox County, City of Knoxville, and Town of Farragut to seek maximum credit under the CRS Program. The current planning progress is presented in red text in the table below:

10-Step Mitigation Planning Process

FEMA 4 Phase Guidance	FEMA Local Mitigation Planning Handbook Tasks (44 CFR Part 201)	Community Rating System (CRS) Planning Steps (Activity 510)
Phase I Organize Resources	Task 1: Determine the Planning Area and Resources	Step 1. Organize to Prepare the Plan Completed
	Task 2: Build the Planning Team 44 CFR 201.6(c)(1)	
	Task 3: Create an Outreach Strategy 44 CFR 201.6(b)(1)	Step 2. Involve the public Ongoing with flyers, survey, and public meetings
	Task 4: Review Community Capabilities 44 CFR 201.6(b)(2) & (3)	Step 3. Coordinate with Other Agencies Completed
Phase II Assess Risks	Task 5: Conduct a Risk Assessment 44 CFR 201.6(c)(2)(i) 44 CFR 201.6(c)(2)(ii) & (iii)	Step 4. Assess the hazard(s) Discussion Today
		Step 5. Assess the problem(s) Discussion Today
Phase III Develop a Mitigation Plan	Task 6: Develop a Mitigation Strategy 44 CFR 201.6(c)(3)(i); 44 CFR 201.6(c)(3)(ii); and 44 CFR 201.6(c)(3)(iii)	Step 6. Set goals Completed
		Step 7. Review possible activities Next HMPC Meeting
		Step 8. Draft an action plan Next HMPC Meeting
Phase IV Implement the Plan and Monitor Progress	Task 8: Review and Adopt the Plan	Step 9. Adopt the plan
	Task 7: Keep the Plan Current	Step 10. Implement, evaluate, revise
	Task 9: Create a Safe and Resilient Community 44 CFR 201.6(c)(4)	

Planning for Public Involvement

Potential methods for involving the public in the planning process were discussed at the Kickoff Meeting using a tiered format geared to inform, educate, and engage the public. Thus far, information has been added to community websites, a public flyer is available providing an overview of hazard mitigation planning and information on the public meeting, and a public survey is available for community participation:

- https://www.surveymonkey.com/r/Knox_Mitigation

Thus far, there have been over 100 responses to the survey. Results are included in Appendix C.

Hazard Identification and Risk Assessment

For each hazard, the profile, recommended risk analysis method, and results of the vulnerability analysis were reviewed. The PowerPoint presentation, as included in Appendix A, presents the details of the vulnerability analysis. Draft Chapter 3 “Risk Assessment” will be provided to the HMPC for review, following the inclusion of discussion points brought up during the meeting.

The following is a summary of discussion points for specific hazards/topics:

- Critical Facilities – KGIS will provide “points of interest” and daycare information to replace the existing critical facilities list from Hazus.

- Drought – The agriculture acreage from the 2012 Ag Crop Census will be utilized, as opposed to zoning or parcel data, to determine the agricultural area vulnerable to drought. Amec Foster Wheeler will also contact the local Agricultural Extension office for confirmation of agricultural area.

- Earthquake – Currently, probability is determined based on the number of occurrences of earthquakes without regard to magnitude. The probability will be updated based upon the number of occurrences of earthquakes with a magnitude greater than 3.0.

- Flood – For flash flood and urban/stormwater flooding events, each community will provide information on drainage complaints within the communities noting location and associated complaint.

- Land Subsidence/Sinkholes – This hazard will be separated into two individual hazards. In addition, Amec Foster Wheeler will coordinate with TDEC on potential sinkhole susceptibility mapping. Local public works departments and KUB will provide updated data on recent sinkhole events. The capability assessment will be updated for the Town of Farragut to note the sinkhole ordinance.

- Wildfire – Rural Metro Fire will coordinate data collection and reporting of local and state wildfire incidents as entered into the National Fire Incident Reporting System (NFIRS).

Next Steps

Amec Foster Wheeler

- Distribute Risk Assessment Chapter 3 to Planning Committee
- Prepare 2nd Public Outreach Flyer for upcoming meeting

HMPC Members/Attendees

- Review Risk Assessment Chapter 3 – return comments and/or track changes to DropBox site or email
- Review existing Plan and Mitigation Actions from 2011 Plan https://www.knoxcounty.org/stormwater/pdfs/Hazard_Mitigation_Plan.pdf
- Update website with public outreach information
- Send Letters to Other Stakeholders

Next Meeting

- HMPC Meeting, Mitigation Actions - October 25th
    - 1:00 to 3:00pm
    - City of Knoxville Public Works Large Conference Room
      3131 Morris Avenue, Knoxville, TN 37909
    - NOTE: THIS MEETING IS ONE HOUR EARLIER – STARTING AT 1pm, in order to prepare for public meeting
- Public Meeting, Mitigation Actions: October 25th
    - 5:00 to 7:00pm
    - Also at the City of Knoxville Public Works Large Conference Room
      3131 Morris Avenue, Knoxville, TN 37909

Attachment A – PowerPoint Presentation

Knox County, City of Knoxville, and Town of Farragut
Multi-Jurisdictional Local Hazard Mitigation Plan
UPDATE
Risk Assessment Meeting
September 26, 2017

Cindy Popplewell
Amec Foster Wheeler
Environment & Infrastructure, Inc.

Agenda

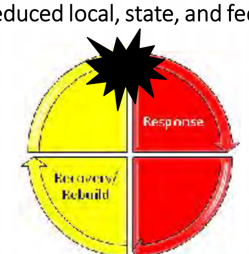
1. Review
   - ✓ Benefits of the hazard mitigation plan
   - ✓ Planning process and progress
   - ✓ Update on public survey
2. Hazard Identification and Risk Assessment (HIRA)
   - ✓ Review hazard profiles
   - ✓ Consensus on planning significance/relative risk
   - ✓ Discuss data gaps and analysis needs
3. Next Steps of Planning Process
   - ✓ Document Review
   - ✓ Mitigation Action Update
   - ✓ Confirm date for next HMPC and Public meeting

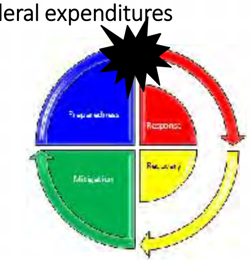
Introductions

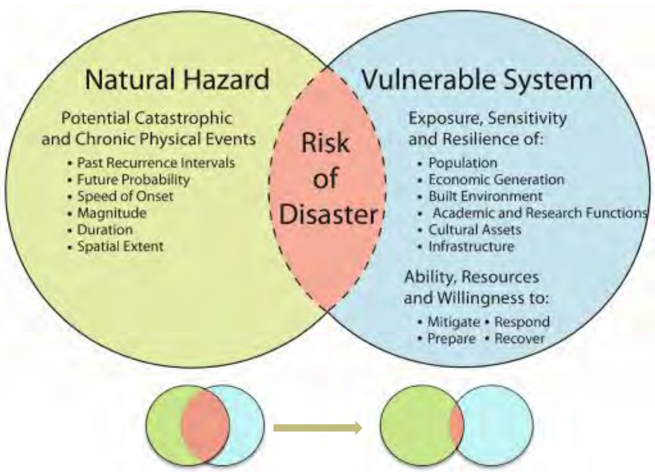
- Name
- Organization

Benefits of the Hazard Mitigation Plan

1. Eligibility for federal disaster assistance (mitigation funding)
   - ✓ April 2, 2015 – Severe Winter Storm and Flooding
   - ✓ July 20, 2011 – Severe Storms, Straight-line Winds, Tornadoes, and Flood
   - ✓ May 1, 2011 – Severe Storms, Straight-line Winds, Tornadoes, and Flood
2. Reduced losses from hazard events
3. Reduced local, state, and federal expenditures







10-Step Planning Process

ORGANIZE RESOURCES

1. Get Organized
2. Plan for Public Involvement
3. Coordinate with Other Departments and Agencies

ASSESS HAZARDS AND RISK

4. Identify Hazards
5. Assess the Risks

DEVELOP MITIGATION PLAN

6. Set Planning Goals
7. Review Possible Activities
8. Draft an Action Plan

IMPLEMENT THE PLAN

9. Adopt the Plan
10. Implement the Plan, Evaluate Work, Revise as Needed

10-Step Planning Process

ORGANIZE RESOURCES

1. Get Organized
2. Plan for Public Involvement
3. Coordinate with Other Departments and Agencies

ASSESS HAZARDS AND RISK

4. Identify Hazards
5. Assess the Risks

DEVELOP MITIGATION PLAN

6. Set Planning Goals
7. Review Possible Activities
8. Draft an Action Plan

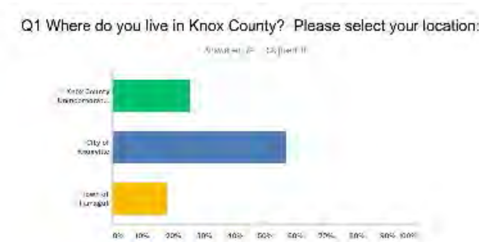
IMPLEMENT THE PLAN

9. Adopt the Plan
10. Implement the Plan, Evaluate Work, Revise as Needed

Public Survey Update

- ✓ 79 completed surveys so far—help publicize survey
- ✓ Survey Monkey—notify public, provide link in newsletters, on websites, in utility mailers, via social media, etc.

  https://www.surveymonkey.com/r/Knox_Mitigation
- ✓ Hard Copy Surveys?
- ✓ Survey – set close date, October 13 or 20th



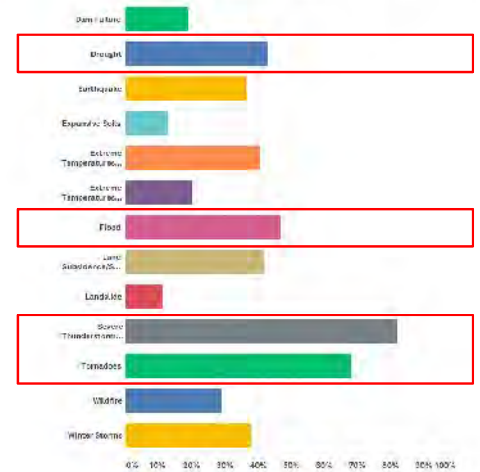
Q2. Have you ever experienced or been impacted by a disaster?

- Yes – 41.03%
- No – 58.97%

Q3. How concerned are you about the possibility of being impacted by a disaster?

- Not concerned – 15.19%
- Somewhat concerned – 68.35%
- Extremely concerned – 16.46%

Q4 What natural hazards do you feel pose a threat to you? Please check all that apply:



Q5. Is there another hazard that you think is a threat?

- Climate change
- Trees – falling, clogging drainage ditch
- Chemical/Nuclear Event
  - Oak Ridge
  - Watts Bar Nuclear Plan
- Structural Fire
- Hazardous materials incident
  - Railroad derailment
  - Interstate

10-Step Planning Process

ORGANIZE RESOURCES

1. Get Organized
2. Plan for Public Involvement
3. Coordinate with Other Departments and Agencies

ASSESS HAZARDS AND RISK

4. Identify Hazards
5. Assess the Risks

DEVELOP MITIGATION PLAN

6. Set Planning Goals
7. Review Possible Activities
8. Draft an Action Plan

IMPLEMENT THE PLAN

9. Adopt the Plan
10. Implement the Plan, Evaluate Work, Revise as Needed

Hazard Identification and Risk Assessment

1. Hazard Identification
   - ✓ Tennessee State Hazard Mitigation Plan
   - ✓ Previous Disaster Declarations
   - ✓ Previous Multi-Jurisdictional Local Hazard Mitigation Plan
2. Hazard Profiles
   - ✓ Description
   - ✓ Geographic Location
   - ✓ Previous Occurrences
   - ✓ Probability of Future Occurrences
   - ✓ Magnitude/Severity
   - ✓ Changing Future Conditions
3. Vulnerability Assessment
   - ✓ Inventory Assets
   - ✓ Estimate Losses ($)

amec foster wheeler | farragut

Hazard Identification

TN State Mitigation Plan 2013	Previous Local Mitigation Plan
Dam/Levee Failure	Dam Failure
Drought	Drought
Earthquake	Earthquake
Extreme Temperature (Heat/Cold)	Extreme Temperatures (Heat/Cold)
Flood	Flood
Geologic	
- Expansive Soils	Expansive Soils
- Land Subsidence and Sinkholes	Land Subsidence and Sinkholes
- Landslide	Landslide
Severe Weather	Severe Storms (High Wind Lightning, Hail)
- Hail	
- High Wind	
- Lightning	
- Thunderstorm Wind	
- Winter Storm	Winter Storms
---- Ice Storm	
---- Heavy Snow	
Tornado	Tornado
Wildfire	Wildfire
Communicable Disease	
Hazardous Materials Release	
Terrorism	
Infrastructure Incident	

amec foster wheeler | farragut

Hazard Profiles

- Likelihood of future occurrence
  - Highly Likely (4): Near 100% probability in next year.
  - Likely (3): Between 10 and 100% probability in next year or at least one chance in ten years.
  - Occasional (2): Between 1 and 10% probability in next year or at least one chance in next 100 years.
  - Unlikely (1): Less than 1% probability in next 100 years.
- Spatial Extent
  - **Extensive (3):** 50-100% of planning area
  - **Significant (2):** 10-50% of planning area
  - **Limited (1)**: Less than 10% of planning area
- Magnitude/Severity
  - Catastrophic (4): Multiple deaths, complete shutdown of facilities for 30 or more days, more than 50 percent of property is severely damaged
  - Critical (3): 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.
  - Limited (2): 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.
  - Negligible (1): 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

* See Handout #1

amec foster wheeler | farragut

4. Identify the Hazards (2011)

Hazard	Probability	Magnitude	Spatial Extent	Planning Significance	Ranking
Flood	4	2	3	3.1	High ☆
Extreme Temperatures	4	2	3	3.1	High
Severe Storms	4	2	3	3.1	High ☆
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

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

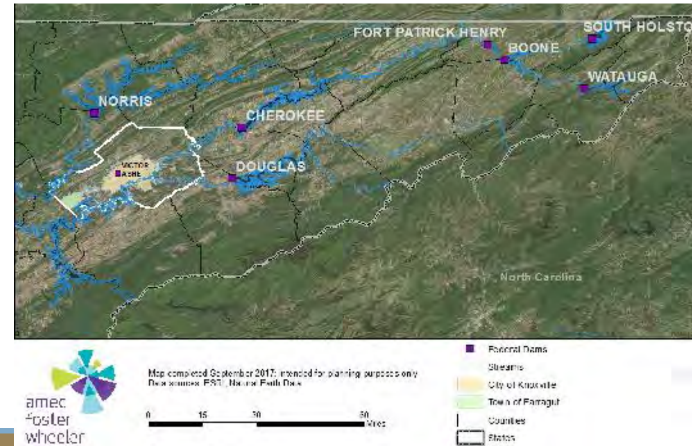
amec foster wheeler | farragut

Dam Failure

- Regulated dams in Knox County
  - 1, Victor Ashe, tributary of Third Creek
  - Low hazard, max storage 25 acre-feet
- Upstream of Planning Area
  - 7 federally regulated dams - TVA

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

Dam Failure



Dam Failure

- ✓ Spatial Extent: Significant - 10-50% of planning area
- ✓ Previous Occurrences: No dam failures reported
- ✓ Probability: Because dam failure is generally a secondary effect of other causes and hazards, calculating probability is difficult.
  - Unlikely - Less than 1% probability in next 100 years.
- ✓ Magnitude/Severity: 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.

Probability	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)

Dam Failure

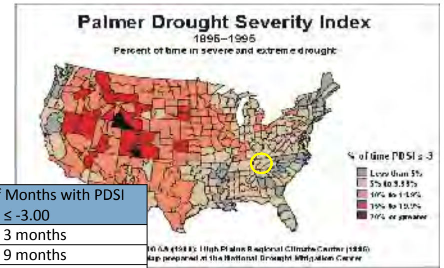
2017 Plan Update

- ✓ No significant changes to hazard profile
- ✓ Changing Future Conditions
  - With heavy reliance on other causes like design error, inadequate maintenance and upkeep, changing future conditions are not directly related to dam failure.
  - However, increased rainfall and flooding events are predicted to occur in the future which could potentially put a stress on dams and increase the likelihood of dam failure.
- ✓ Include mitigation action to address preparedness, such as training exercises and emergency action plans

Drought

- A period of excessive dryness long or intense enough to result in water-related problems.
- Slow moving hazard which causes losses to agriculture; contributes to wildfire; and affects domestic water supply, energy production, public health, and wildlife.
- Agricultural Areas
  - 2012 Ag Census – 65,347 acres farm land; 20.1% of County land area
  - Existing Land Use - agriculture/Forestry/vacant land 152,633 acres; 46.9% of County land
  - KGIS Parcel Database - Land Use as Agriculture 116,603 acres; 35.8% of County land

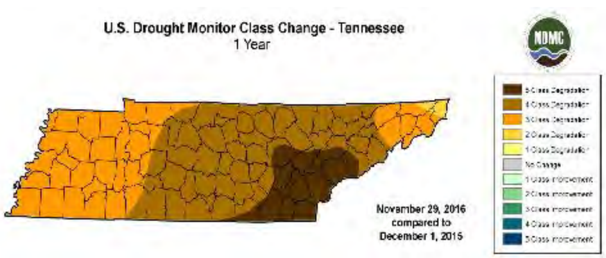
Drought



Year	Number of Months with PDSI ≤ -3.00
2013	3 months
2012	9 months
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

During 67- year period (804 months), eastern Tennessee was in severe to extreme drought for 65 months. This equates to 8.1 percent of the time.

Drought



Drought

- ✓ Spatial Extent: Significant - 10-50% of planning area
- ✓ Previous Occurrences:
  - 1952 – 1955; 1981; 1986 – 1988; 2007 – 2008; 2012 - 2013
- ✓ Probability: Occasional - Between 1 and 10% probability in next year or at least one chance in next 100 years.
- ✓ Magnitude/Severity: 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.

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	2-Occaisonal	2-Limited	2-Significant	2.0 (Medium)
Knox County (Unincorporated)	2-Occaisonal	2-Limited	2-Significant	2.0 (Medium)
City of Knoxville	2-Occaisonal	2-Limited	2-Significant	2.0 (Medium)
Town of Farragut	2-Occaisonal	2-Limited	2-Significant	2.0 (Medium)

Drought

2017 Plan Update

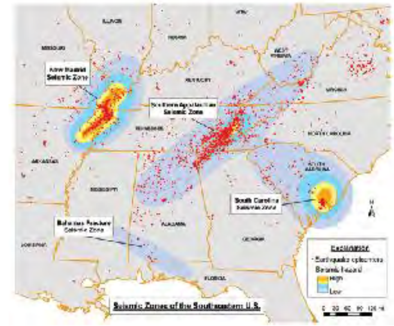
- ✓ Update previous occurrences and agricultural area
- ✓ Update spatial extent; raise significance to medium
- ✓ Changing Future Conditions
  - – Typical characteristics of drought across the U.S. are altering due to a changing climate according to NOAA. A changing future climate is more likely to result in droughts being drier than expected because warmer temperatures increasing evaporation. Changing climate predications also show drought intensity and risk increasing.
- ✓ Continue to monitor water and climate data to better understand local climate and drought history; monitor water supply; development of drought emergency plan; conservation; TN State Drought Management Plan

farragut

Earthquake

amec foster wheeler

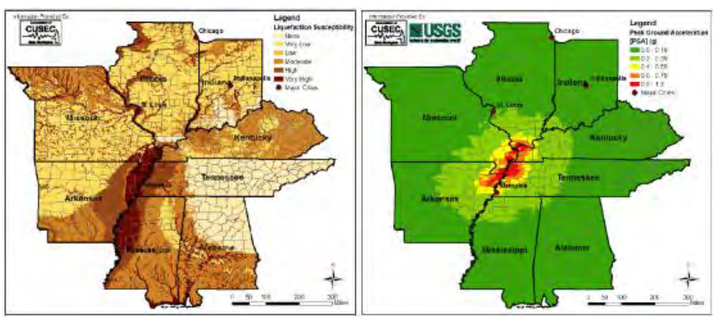
- East Tennessee Seismic Zone within the Southern Appalachian Seismic Zone
- One to two earthquakes with magnitudes equal to or greater than 3.0 are expected in the SASZ per year.



farragut

Earthquake

amec foster wheeler

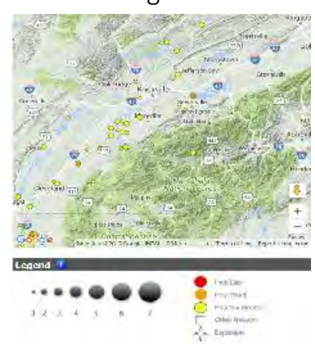


Ground Motion Maps for magnitude 7.7 earthquake

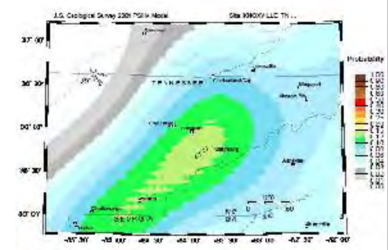
farragut

Earthquake

- Previous Occurrences Feb – Aug 2017



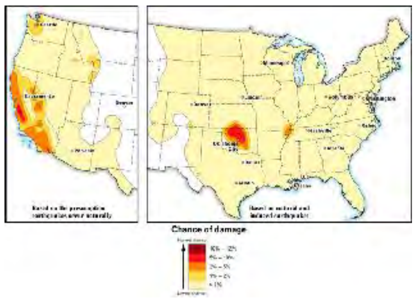
- Probability



farragut

Earthquake

- 2017 One Year Model
- High seismic hazard (greater than 1% probability of potentially damaging ground shaking in one year)



Earthquake

- ✓ **Spatial Extent:** Extensive, 50-100% of planning area
- ✓ **Previous Occurrences: Knox Area** – Since 1989, recent earthquakes near Knox County have not exceeded a 2.7 magnitude; No structural damage
- ✓ **Probability:** Likely, 10-100% chance of occurrence
- ✓ **Magnitude/Severity:** 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

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	3-Likely	1-Negligible	3- Extensive	2.3 (Medium)
Knox County (Unincorporated)	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)

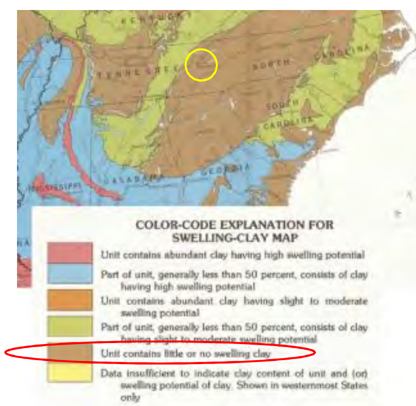
Earthquake

2017 Plan Update

- ✓ No significant changes to hazard profile, utilized 2014 National Seismic Hazard Map
- ✓ Changing Future Conditions
  - The relationship between earthquakes and changing climate conditions is still very new research. However, early research suggests increased flooding and rain causing landslides and erosion could potentially increase fault activities by reducing the weight on a fault or by loosening fault planes, allowing it to move more easily. If precipitation increases to more frequent torrential rain events, the risk of earthquakes could also increase.
- ✓ Building codes and structural retrofits

Expansive Soils

- Contain minerals such as smectite clays
- Expand when water is added, and shrink when they dry out



Expansive Soils

- ✓ Spatial Extent: <u>Limited</u>, less than 10% of planning area
- ✓ Previous Occurrences: None reported
- ✓ Probability: <u>Unlikely</u>, <1% chance of occurrence
- ✓ Magnitude/Severity: <u>Negligible</u> - 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.

Probability	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)

Expansive Soils

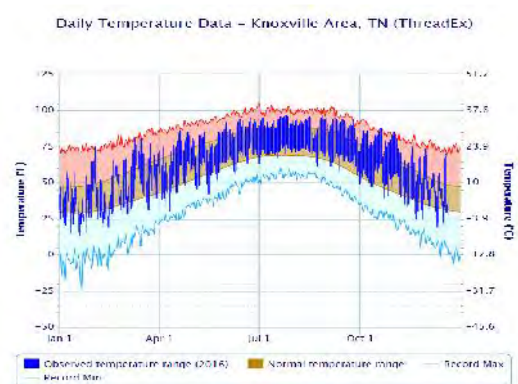
<u>2017 Plan Update</u>

- ✓ No significant changes to hazard profile
- ✓ Changing Future Conditions
  - – With limited amounts of clay soil, it is unlikely that damage or frequency of events would increase or decrease.
- ✓ Soil analysis for construction projects

Extreme Temperatures

- Summer Average High - 87°
  - Temperatures consistently stay 10° above average high temperature
- Winter Average Low - 31°
  - Wind Chill Advisory when temperatures are expected to reach –5°F to –14°F and winds of greater than 10 mph for at least 3 hours.
- Urban areas develop and buildings and roads replace open land and vegetation, urban regions become warmer than their rural surroundings, forming an "island" of heat.
- Persons over 65 and under 5 yrs are especially vulnerable.
- Knoxville-Knox County Excessive Heat Plan

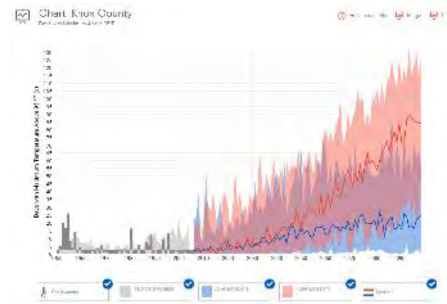
Extreme Temperatures

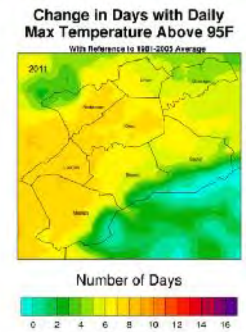


Extreme Temperatures

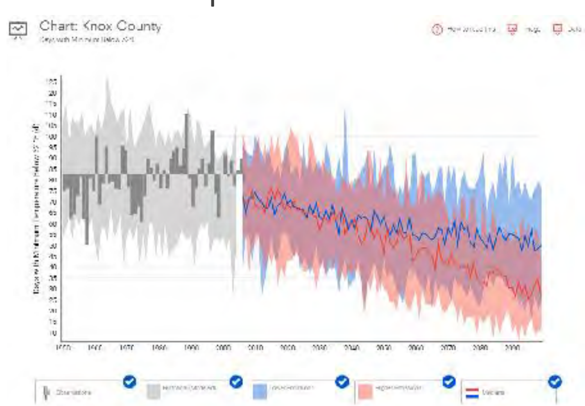
- Summer Average High - 87°
  - Temperatures consistently stay 10° above average high temperature
- Winter Average Low - 31°
  - Wind Chill Advisory when temperatures are expected to reach –5°F to –14°F and winds of greater than 10 mph for at least 3 hours.
- Urban areas develop and buildings and roads replace open land and vegetation, urban regions become warmer than their rural surroundings, forming an "island" of heat.
- Persons over 65 and under 5 yrs are especially vulnerable.
- Knoxville-Knox County Excessive Heat Plan
- https://toolkit.climate.gov/climate-explorer2/

Extreme Temperatures





Extreme Temperatures



Extreme Temperatures

- ✓ **Spatial Extent:** High - 50-100% of planning area of the total population adversely affected should the hazard occur
- ✓ **Previous** Occurrences: January 1, 1950 to August 23, 2017, temperatures above 90 degrees Fahrenheit occurred an average of 34 times each year while temperatures below 10 degrees Fahrenheit occurred an average of 2.5 times per year.
- ✓ **Probability:** Highly Likely - Near 100% probability in next year.
- ✓ **Magnitude/Severity:** 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.

Probability	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)

Extreme Temperatures

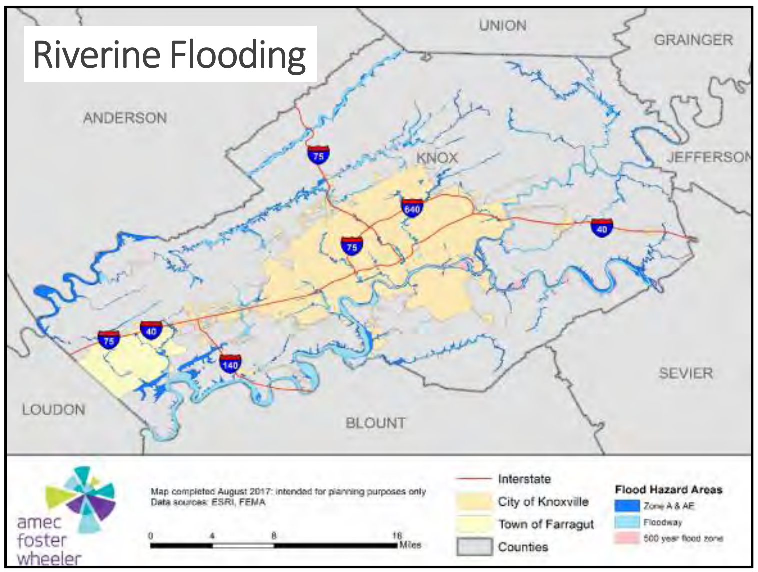
2017 Plan Update

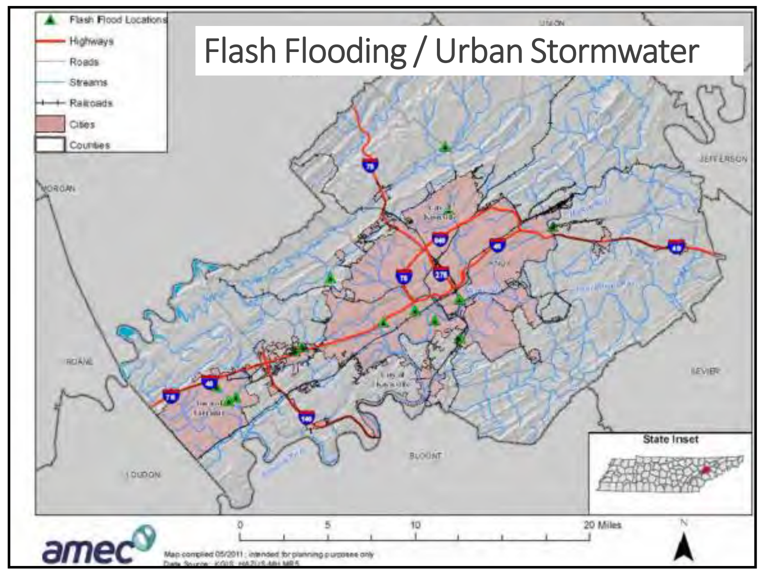
- ✓ Updated profile with data from Oak Ridge National Lab
- ✓ Changing Future Conditions
  - Heat: In the Southeast, maximum temperatures have not been increasing compared to other parts of the U.S. However, the warm minimum temperature has been increasing meaning that during warmer parts of the year, the coldest days are getting warmer. This is important because human health relies on cooler nights and cooler nights are going away. Changing future conditions also influence heat waves. Models predict there will be more heat wave events and they will last longer with more consecutive days.
  - Cold: With changing future conditions, it is predicted that there will be a decrease in cold air outbreaks.

Flood

Floods are among the most frequent and costly natural disaster in terms of human hardship and economic loss

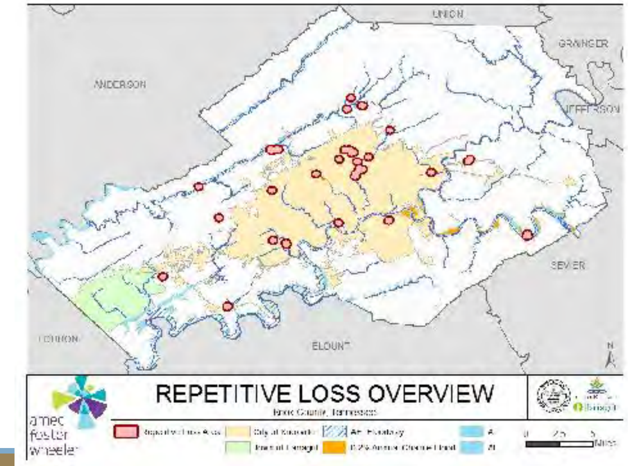
- ✓ **Riverine –** an event when a watercourse exceeds its "bank-full" capacity and is the most common type of flood event. Riverine floods result from precipitation over large areas.
- ✓ **Flash Flooding –** localized floods of great volume and short duration
- ✓ **Sinkhole Flooding** - occurs when surface drainage goes underground into sinkholes, rather than continue to drain into tributaries and rivers that are part of the surface drainage basin.
- ✓ **Urban Stormwater –** land loses its ability to absorb rainfall as it is converted from fields or woodlands to roads, buildings, and parking lots





Sinkhole Flooding Ten Mile Creek

Repetitive Loss Properties



RLP Statistics

Repetitive Loss: Any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. Two of the claims paid must be more than 10 days apart but, within 10 years of each other. A repetitive loss property may or may not be currently insured by the NFIP.

Severe Repetitive Loss: As defined by the Flood Insurance Reform Act of 2004, SRLs are 1-4 family residences that have had four or more claims of more than $5,000 or at least two claims that cumulatively exceed the building's value. The Act creates new funding mechanisms to help mitigate flood damage for these properties.

Number of Properties	17	36
Number of Losses	45	107
Average Payment	$12,111	$22,968
Building Payments	$461,611.76	$1,862,167.35
Contents Payments	$83,414.82	$595,513.11
Total Payments	$545,026.58	$2,457,680.46

Flood

- ✓ Location: Extensive – 50-100% of planning area
- ✓ Previous Occurrences: - From 1997 to 2017, there were 42 records of flood or flash flood events. The average number of flood and flash flood events calculates to 4.2 per year.
- ✓ Probability: Highly Likely - Near 100% probability in next year.
- ✓ Magnitude/Severity: 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.

Probability	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)

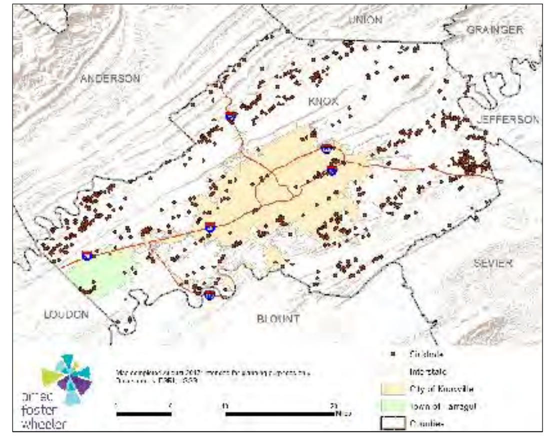
Flood

2017 Plan Update

- ✓ Updated previous occurrences; utilize updated DFIRM data for risk assessment; updated repetitive loss information
- ✓ Changing Future Conditions
  - – an increase in global temperatures;
  - – an increase in heavier precipitation due to increase in evaporation and since warmer air can hold more moisture.
  - – Increasing frequency and intensity of heavy rainfall is expected which increases the risk of flooding.
- ✓ Address repetitive loss properties and associated areas; noted flash flooding/urban stormwater problem areas; identify areas of mitigation interest

Land Subsidence/Sinkholes

- Ground above a manmade or natural void collapses
- Gradual settling or sudden sinking
- Areas of karst have greater risk.



Land Subsidence

- ✓ Spatial Extent: Significant – 10-50% of planning area
- ✓ Previous Occurrences: – During the period from 2000-2017, there were six documented damaging sinkholes.
- ▪ Probability: Likely: Between 10 and 100% probability in next year or at least one chance in ten years.
- ✓ Magnitude/Severity: Limited — In general, when sinkholes occur, impacts are limited to a fairly small area and the magnitude of damages is "limited."

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	3-Likely	2-Limited	2-Significant	2.45 (Medium)
Knox County (Unincorporated)	3-Likely	2-Limited	2-Significant	2.45 (Medium)
City of Knoxville	3-Likely	2-Limited	2-Significant	2.45 (Medium)
Town of Farragut	3-Likely	2-Limited	1-Limited	2.25 (Medium)

Land Subsidence

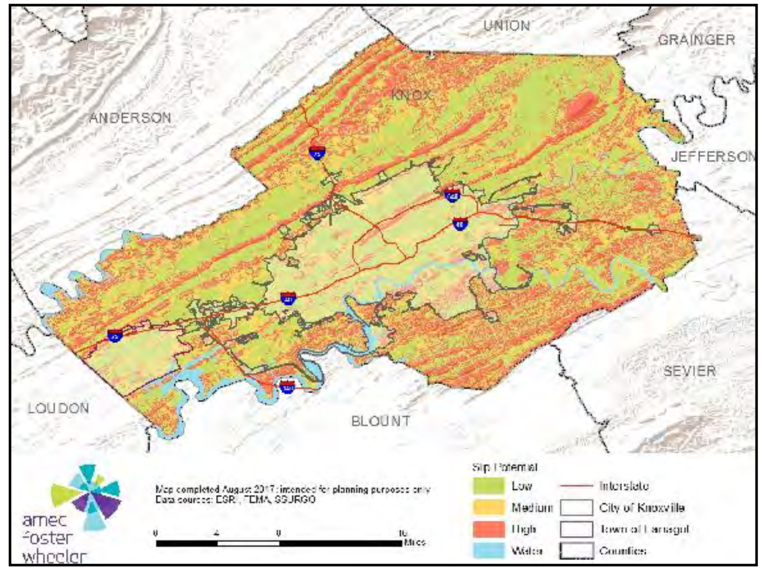
2017 Plan Update

- ✓ Update probability to "likely"
- ✓ Changing Future Conditions
  - – Changing in future conditions raise the likelihood of extreme weather, meaning the torrential rain and flooding conditions which often lead to the exposure of sinkholes are likely to become increasingly common. Certain events such as a heavy precipitation following a period of drought can trigger a sinkhole due to low levels of groundwater combined with a heavy influx of rain.
- ✓ Manage development in sinkhole areas; consider subsidence during building design, monitor areas at risk

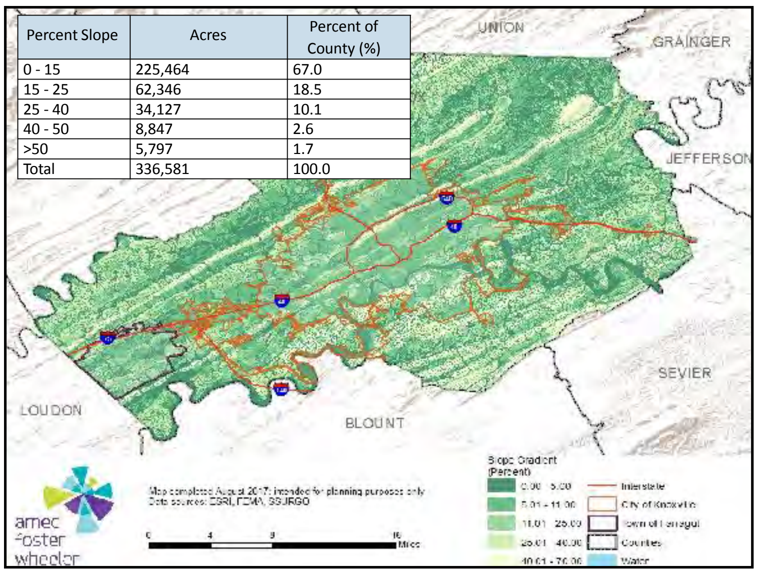
Landslides

- The movement of a mass of rock, debris, or earth down a slope by force of gravity is considered a landslide.
- Landslides occur when the slope or soil stability changes from stable to unstable, which may be caused by earthquakes, storms, volcanic eruptions, erosion, fire, or additional human-induced activities.
- Slopes greater than 10 degrees are more likely to slide, as are slopes where the height from the top of the slope to its toe is greater than 40 feet.
- Knoxville-Knox County Hillside and Ridgetop Protection Plan

farragut



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



Landslides

- ✓ Spatial Extent: Significant - 10-50% of planning area
- ✓ Previous Occurrences: Two documented damaging events in the 16-year period from 2000-2017 = 11.1% probability. In addition, it is probable that other smaller scale slides may have occurred that were not reported.
- ✓ Probability: Likely - Between 10 and 100% probability in next year
  Magnitude/Severity: 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.

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	3-Likely	2-Limited	2-Significant	2.45 (Medium)
Knox County (Unincorporated)	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)

farragut

Landslides

2017 Plan Update

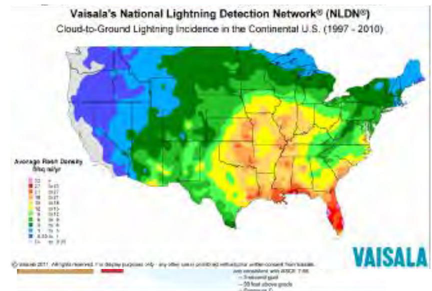
- ✓ Incorporation of slip potential and slope gradient data
- ✓ Changing Future Conditions
  - – Future conditions expect an increase in heavy rainfall which can lead to more erosion and landslides. The expansion of urban and recreational developments into hillside also puts more people at risk of landslides. Since landslides commonly occur along with other natural disasters like floods, there is a possibility of more landslides due to the increasing threat of flooding.
- ✓ Manage development in high hazard areas

farragut

Severe Storms

amec foster wheeler

- Localized storms accompanied by hail, high winds, lightning, heavy rain causing flash flooding and sometimes tornadoes.



- Power outages from downed power lines. Manufactured homes, campers and light buildings at increased risk of damages.

farragut

Severe Storms

- ✓ Spatial Extent: Extensive - 50-100% of planning area
- ✓ Previous Occurrences (Since 2001):
  - High Wind – 29 Severe thunderstorms with high wind
  - Hail – 97 events
  - Lightning – 6 events
- ✓ Probability: Highly Likely - Near 100% probability in next year.
- ✓ Magnitude/Severity: 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.

Probability	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)

Severe Storms

2017 Plan Update

- ✓ Update to previous occurrences
- ✓ Changing Future Conditions
  - – Hail: Future atmospheric conditions are predicted to have more CAPE and a decrease in wind shear. An increase in CAPE and decrease in wind shear are not favorable environments for hail. It may appear to be an increase in hail events or increase in damage caused by hail over the last decade but there is a bias since reporting and data collection for hail data began in 1950.
  - – High winds: Wind speeds have increased globally over the past 20 years; however, it is not clear whether it is due to climate change or if it's part of a cyclical pattern.

farragut

Severe Storms

2017 Plan Update

- ✓ Changing Future Conditions
  - – Lightning: With atmospheric conditions favoring more CAPE there is a possibility for more storms. However, there it is still debate about whether there will be an increase or decrease with most research favoring an increase in CAPE and precipitation resulting in more lightning events. Most possible impacts are focused around forest fire implications.
- ✓ Include public awareness; insurance; protect critical facilities and equipment from lightning damage; building codes to address wind damage; public survey noted concern for downed trees

Tornado

- A tornado is a violently rotating column of air that has contact with the ground and is often visible as a funnel cloud.
- The destruction caused by tornadoes ranges from light to catastrophic depending on the intensity, size, and duration of the storm.

Tornado

Tornado

- ✓ Spatial Extent: Limited - Less than 10% of planning area
- ✓ Previous Occurrences (Since 1950): 15 tornado events; 7 were rated F0, 5 were rated F1, 2 were rated F2, 1 was rated F3.
- ✓ Probability: Likely - Between 10 and 100% probability in next year or at least one chance in ten years.
- ✓ Magnitude/Severity: 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.

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	3-Likely	2-Limited	1-Limited	2.25 (Medium)
Knox County (Unincorporated)	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)

Tornado

2017 Plan Update

- ✓ Update previous occurrences and mapping of paths; adding info on timing of tornado events
- ✓ Changing Future Conditions
  - Current research suggests an increase in more tornadoes outbreaks due to changing heat and moisture content in the atmosphere brought on by a warming world. The number of days with large outbreaks has been increasing since the 1950s, but areas that normally see tornado activity are not expanding. Therefore, it should be expected to see more tornadoes on fewer days in areas that already experience tornadoes.
- ✓ Safe room construction; building codes addressing wind resistance; public awareness; warning capabilities

farragut

Wildfire

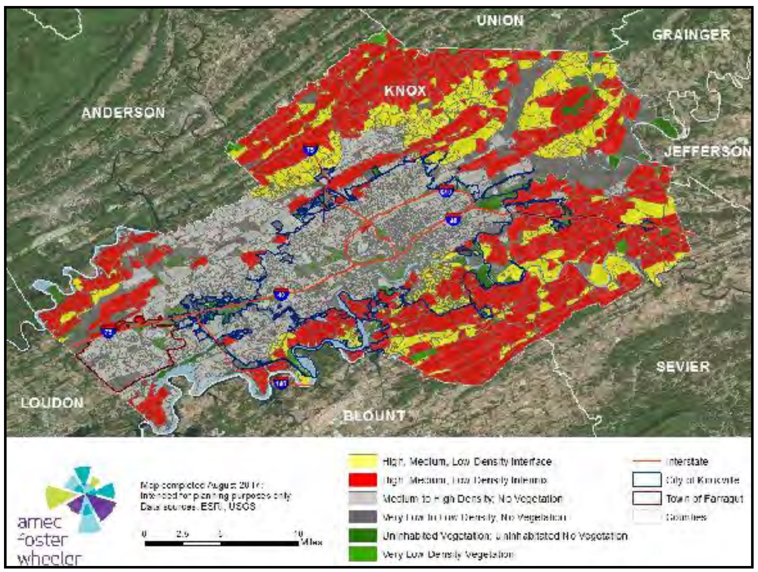
amec foster wheeler

- Uncontrolled fire in combustible vegetation that occurs in the countryside or wilderness area

Year	# Fires	Acres Burned
2005	6	21
2007	16	513
2008	7	119
2009	11	177
2010	6	10
Totals	46	840

- WUI – Interface/Intermix Area
  - Intermix communities are places where housing and vegetation intermingle. In intermix, more than 50 percent vegetation and more than 1 house per 16 ha.
  - Interface communities are areas with housing in the vicinity of contiguous vegetation. Interface areas have more than 1 house per 40 acres, have less than 50 percent vegetation, and are within 1.5 mi of an area (made up of one or more contiguous Census blocks) over 1,325 acres (500 ha) that is more than 75 percent vegetated.

farragut



Wildfire

amec foster wheeler

- ✓ **Spatial Extent:** Limited – Between 10% to 25% of the total population adversely affected should the hazard occur
- ✓ **Previous Occurrences:** Occur on annual basis, TN Dept of Forestry
- ✓ **Probability:** Highly Likely - Near 100% probability in next year.
- ✓ **Magnitude/Severity:** 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

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	4-Highly Likely	1-Negligible	1-Limited	2.35 (Medium)
Knox County (Unincorporated)	4-Highly Likely	1-Negligible	3-Extensive	2.75 (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)

farragut

Wildfire

2017 Plan Update

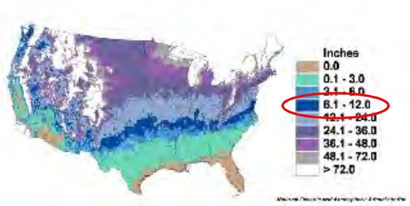
- ✓ Update previous occurrences and WUI mapping
- ✓ Changing Future Conditions
  - – Drought is anticipated to increase in frequency and intensity during summer months under projected future scenarios. Drought can lead to dead or dying vegetation which creates fodder for wildfires within both urban and rural settings. Higher temperatures also reduce the number of days prescribed burning can be performed. Also an increase in the wildland-urban interface puts more people in threat of wildfires. Reduction of prescribed burning will allow growth of understory vegetation, providing more fuel for destructive wildfires.
- ✓ Land use planning; fire-resistant construction practices; defensible space

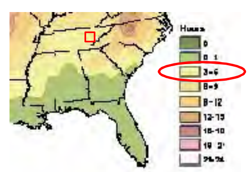
Severe Winter Storms

- Winter storm conditions include:
  - **Blizzard**—Winds of 35 mph or more; reduced visibility to less than 1/4 mile for ~3 hours.
  - **Blowing Snow**—Wind-driven snow that reduces visibility.
  - **Snow Squalls**—Brief, intense snow showers accompanied by strong, gusty winds.
  - **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. **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.
- Property damage, power, phone outages, and closures of streets, highways, schools, businesses, and nonessential government operations

Severe Winter Storms

Annual Mean Total Snowfall





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://wf.ncdc.noaa.gov/oa/climate/online/ccd/snowfall.html

Severe Winter Storms

- ✓ **Spatial Extent:** Extensive - 50-100% of planning area
- ✓ **Previous Occurrences (1993-2017):** 39 recorded winter storm events (snow and ice) in the planning area resulting in an average of one and a half winter storms per year.
- ✓ **Probability:** Highly Likely - Near 100% probability in next year.
- ✓ **Magnitude/Severity:** 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

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	4-Highly Likely	1-Negligible	3-Extensive	2.75 (Medium)
Knox County (Unincorporated)	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)

Severe Winter Storms

<u>2017 Plan Update</u>

- ✓ Updated previous occurrences and winter precipitation
- ✓ Changing Future Conditions
  - – During the last century, the South has seen a reduction in snowstorm frequency. It is predicted that in a changing climate that there will be continue to be fewer snowstorms in the South.
- ✓ Protect power lines and reduce impacts to roadways; public education and outreach; assistance to vulnerable populations

farragut

4. Identify the Hazards (2017)

amec foster wheeler

Hazard	Probability	Magnitude	Spatial Extent	Planning Significance	Ranking
Flood	4	2	3	3.1	High
Extreme Temperatures	4	2	3	3.1	High
Severe Storms	4	2	3	3.1	High
Winter Storms	4	1	3	2.75	Medium
Land subsidence and sinkholes	3	2	2	2.45	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	2	2.0	Medium
Dam Failure	1	2	2	1.55	Low
Expansive soils	1	1	1	1	Low

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

farragut

Let's Take a Break?

Risk Assessment

amec foster wheeler

- Inventory structures/parcels
  - Parcel data from KGIS – review landuse categories
- Inventory critical facilities
- Determine # and value of structures
- Determine # of people in area
  - ✓ Census Block
- Determine vulnerable infrastructure
- Identify development trends/constraints
- Identify historic, cultural, and natural resource areas
- Estimate the $ losses

farragut

Parcel w/ LandUse Information

- KGIS Parcel Data
  - LANDUSE Field
  - Associate each LANDUSE entry with:
    - Agriculture
    - Commercial
    - Education
    - Government
    - Industrial
    - Religion
    - Residential
    - Other

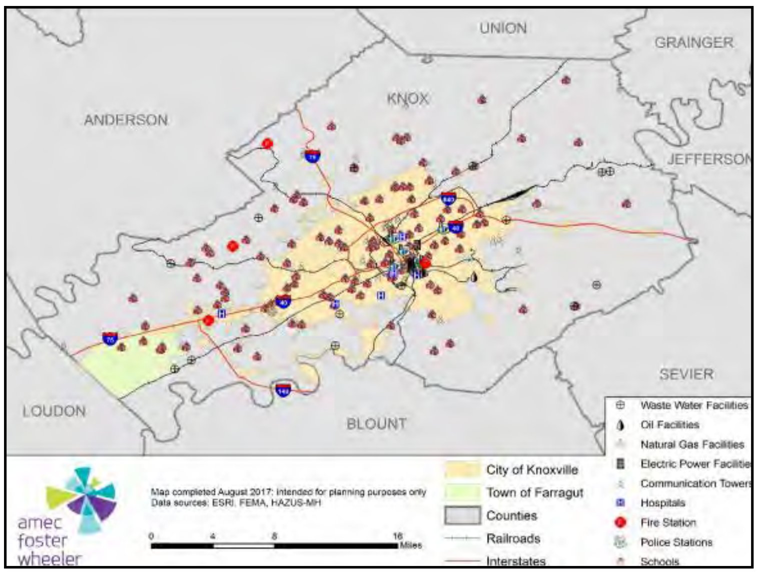
* See Handout #2

Critical Facilities

- EOC
- Fire Stations
- Police Stations
- Schools
- Communication Towers
- Nursing Homes
- Hospitals

Facility	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

* See Handout #3



Risk Assessment Methodology

	Vulnerability and Loss Estimation Method
Dam Failure	• 2011 - Qualitative Analysis • 2017 – Qualitative Analysis; Need inundation mapping for full loss estimation
Drought	• 2011 – Loss of Water Estimate ($93 per person per day) – population based • 2017 – Add crop loss estimations
Earthquake	• 2011 - HAZUS-MH Loss Estimation • 2017 – HAZUS-MH Loss Estimation
Extreme Temperature	• 2011 – Qualitative Analysis; Population statistics • 2017 – Add crop loss estimations
Expansive Soils	• 2011 – Qualitative Analysis • 2017 –Qualitative analysis
Flood	• 2011 - HAZUS-MH Loss Estimation • 2017 - Incorporation of updated FIRM data

Risk Assessment Methodology

	Vulnerability and Loss Estimation Method
Land Subsidence	• 2011 - GIS-based risk modeling; bldg. counts and values over known sinkholes • 2017 - GIS-based risk modeling; bldg. counts and values over known karst areas
Landslide	• 2011 - Qualitative analysis • 2017 - GIS-based risk modeling; Areas of high susceptibility and high incidence, as available
Severe Storms	• 2011 – Loss of power; Annualized property loss • 2017 – Loss of power; Updated annualized property loss
Tornadoes	• 2011 - Statistical Analysis based on housing density • 2017 – Updated Statistical Analysis based on housing density
Wildfire	• 2011 - Statistical Analysis based on previous occurrences, annualized loses • 2017 – GIS Based analysis using Wildfire Urban Interface and Intermix areas, as available
Winter Storm	• 2011 – Loss of power; Annualized property loss • 2017 – Loss of power; Updated annualized property loss

Risk Assessment

- Drought

Jurisdiction	2016 Population Estimate	Loss of Water Estimate ($93 per person per day)
Knox County (Unincorporated)	247,611	$ 23,027,823
City of Knoxville	186,239	$ 17,320,227
Town of Farragut	22,282	$ 2,072,226
Total	**456,132**	**$ 42,420,276**

Table 3.9 Claims Paid in Knox County for Crop Loss as a Result of Drought (2007- 2016)

Year	Crop	Hazard	Claims Paid
2010	All Other Crops	Drought	$3,715
2007	All Other Crops	Drought	$5,156
		Total	$8,871

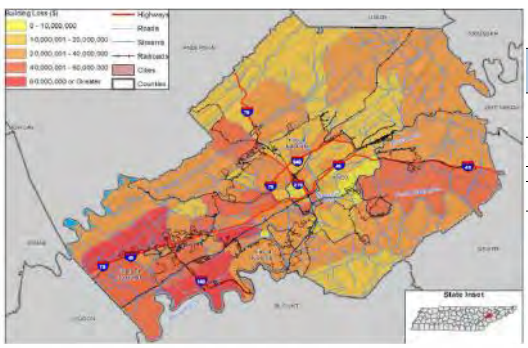
Source: USDA Risk Management Agency, 2017

- $8,871 loss over 10-year period
- Adjust for 83% insured = total loss of $10,687
- Annualized loss = $1,068
- Based on value of crops (loss/value) = 0.01%

Risk Assessment

- Earth

Ju	
Knox (Uni	
City	
Town	
Tota	



Risk Assessment

- Extreme Temperature

Jurisdiction	# Age 65 and Over	% Age 65 and Over	# Age Under 5	% Age Under 5	% Individuals Below Under 5 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

Table 3.15 Claims Paid in Knox County for Crop Loss as a Result of Frost/Freeze (2007- 2016)

Year	Crop	Hazard	Claims Paid
2016	All Other Crops	Freeze	$13,[illegible]
[illegible]	All Other Crops	Frost	$1,[illegible]
201[illegible]	All Other Crops	Frost	$388.00
201[illegible]	All Other Crops	Freeze	$388.00
[illegible]	All Other Crops	Freeze	$1[illegible]
		Total	$28,825

Source: USDA Risk Management Agency, 2017

- $28,825 loss over 10-year period
- Adjust for 83% insured = total loss of $34,729
- Annualized loss = $3,473
- Based on value of crops (loss/value) = 0.04%

Risk Assessment

- Flood - EXAMPLE

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

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

Risk Assessment

- Land Subsidence/Sinkholes

Knox County									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	727	32	9	389	10	32	7	24	1230
Cost of Building	$ 167,040,600	$ 38,793,500	$ 21,883,400	$ 22,257,700	$ 1,079,700	$ 302,900	$23,331,400	$ 420,200	$ 275,109,400
Acres	4,086.92	371.73	658.79	13,887.42	98.90	1,553.59	308.94	299.99	21,266.28
City of Knoxville									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	171	17	3	54	6	15	6	6	278
Cost of Building	$ 43,795,600	$ 31,312,200	$ 1,020,800	$ 1,225,200	$ 1,078,200	$ -	$19,602,800	$ 115,700	$ 275,109,400
Acres	528.31	137.13	27.47	556.62	48.39	647.14	215.95	54.81	2,215.82
Town of Farragut									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	17	3	0	6	0	0	0	0	26
Cost of Building	$ 12,119,400	$ 5,250,100	$ -	$ -	$ -	$ -	$ -	$ -	$ 17,369,500
Acres	32.33	13.36	0.00	232.25	0.00	0.00	0.00	0.00	277.93

Risk Assessment

- Landslide – Soil Slip, High Potential

Knox County									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	37545	780	257	10868	269	434	34	1172	**51359**
Cost of Building	$ 6,459,722,000	$ 722,876,700	$196,046,200	$ 230,334,100	$35,590,000	$ 42,601,000	$57,419,300	$ 29,407,200	**$ 7,773,996,500**
Acres	78,234.16	4,605.83	3,024.81	98,768.76	1,497.97	8,481.37	653.19	3,962.05	**199,228.15**
City of Knoxville									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	11581	442	129	3575	120	321	19	257	**16444**
Cost of Building	$ 2,211,758,800	$ 485,200	$ 2,934,000	$ 65,824,300	$18,706,500	$ 829,300	$ -	$ 1,156,400	**$ 2,301,694,500**
Acres	15276.91	2563.81	1325.00	14547.65	864.62	4733.29	365.59	945.56	**40622.44**
Town of Farragut									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	1842	28	16	403	5	8	3	154	**2459**
Cost of Building	$ 489,935,900	$ 69,022,500	$ 58,417,700	$ 83,278,300	$ -	$ 186,100	$ 662,000	$ 278,400	**$ 701,780,900**
Acres	1,597.86	292.42	1,341.09	3,021.39	24.10	202.41	5.47	304.02	**6,788.75**

Risk Assessment

- Landslide – Slope Class

Knox County									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	7018	183	68	3034	49	109	6	177	10644
Cost of Building	$ 1,423,177,500	$ 146,678,000	$ 23,587,600	$ 77,546,700	$ 8,159,500	$ 2,858,700	$ 8,429,600	$ 17,672,800	$ 1,708,110,400
Acres	25083.64	1394.02	1124.50	38319.12	520.07	3863.18	98.79	1381.83	71785.16
City of Knoxville									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	2904	144	46	1201	21	78	4	69	4467
Cost of Building	$ 672,090,800	$ 135,427,200	$ 21,651,000	$ 17,978,300	$ 6,872,500	$ 2,764,700	$ -	$ 3,107,000	$ 859,891,500
Acres	5572.41	1006.56	705.46	5121.56	363.01	2529.51	28.32	388.41	15715.25
Town of Farragut									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	3	0	0	2	0	0	0	1	6
Cost of Building	$ 1,215,600	$ -	$ -	$ 7,300	$ -	$ -	$ -	$ -	$ 1,222,900
Acres	30.23	0.00	0.00	47.80	0.00	0.00	0.00	53.75	131.78

Risk Assessment

- Severe Storms

Jurisdiction	Population (2016)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
Knox County (Unincorporated)	247,611	24761.1	$ 3,119,899
City of Knoxville	186,239	18623.9	$ 2,346,611
Town of Farragut	22,282	2228.2	$ 280,753
Total	456,132	45613.2	$ 5,747,263

- Tornado

Jurisdiction	Land Area (Sq.Mi.)	Housing Density	Housing in 0.653 Sq. Mi.	Avg. Home Value	Value of Exposed Homes
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

Risk Assessment

- Wildfire – Intermix

Knox County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	23801	325	141	7298	203	148	9	674	32599
Cost of Building	$ 3,343,389,500	$ 114,954,000	$ 53,908,500	$ 154,473,200	$21,058,500	$ 1,714,400	$ 802,800	$ 17,338,200	$ 3,707,639,100
Acres	61072.47	1553.04	1436.21	70654.39	713.22	3914.11	173.66	2089.67	141606.78
City of Knoxville	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	7744	135	42	2306	58	98	3	189	10575
Cost of Building	$ 1,240,287,800	$ 67,209,800	$ 4,755,800	$ 32,752,400	$13,652,100	$ 1,154,800	$ 334,600	$ 1,523,000	$ 1,361,670,300
Acres	12452.63	580.83	199.38	11298.76	250.08	2240.36	133.24	409.32	27564.61
Town of Farragut	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	200	0	4	91	0	0	1	12	308
Cost of Building	$ 51,770,800	$ -	$ -	$ 3,822,900	$ -	$ -	$ 193,500	$ -	$ 55,787,200
Acres	408.87	0.00	38.64	1056.52	0.00	0.00	3.79	86.60	1594.41

- Wildfire - Interface

Knox County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	25438	530	118	4192	175	191	9	409	31062
Cost of Building	$ 3,137,322,400	$ 168,822,100	$ 98,745,800	$ 89,887,800	$13,733,400	$ 6,356,400	$ 2,780,900	$ 29,363,200	$ 3,547,012,000
Acres	28601.36	1202.45	1245.54	35107.34	590.16	3865.38	55.34	1341.82	72009.40
City of Knoxville	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	7533	267	62	1193	65	123	2	80	9325
Cost of Building	$ 826,548,900	$ 103,761,300	$ 63,919,800	$ 8,793,600	$ 2,310,600	$ 3,201,000	$ 69,900	$ 4,276,900	$ 1,012,882,000
Acres	4984.10	582.33	414.50	37138.93	169.63	1962.63	4.42	160.24	45416.78
Town of Farragut	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	0	0	0	0	0	0	0	0	0
Cost of Building	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Acres	0	0	0	0	0	0	0	0	0

Risk Assessment

- Winter Storm

Jurisdiction	Population (2016)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
Knox County (Unincorporated)	247,611	24761.1	$ 3,119,899
City of Knoxville	186,239	18623.9	$ 2,346,611
Town of Farragut	22,282	2228.2	$ 280,753
Total	456,132	45613.2	$ 5,747,263

Let’s Take a Break?

Mitigation Strategy

- Goals
  - ✓ Review/Updated Goals at Kickoff Meeting
- Action Items – Next HMPC Meeting
  - Status Update of Existing Action Items – *homework!*
  - Additional Action Items
  - Prioritization of all Action Items

2011 Goals

- 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 <u>awareness</u> and <u>preparedness</u> by providing information describing all types of hazards, methods for preventing damage, and how to respond.
- Protect critical facilities and infrastructure from natural hazards.

2017 Goals

- 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 <u>awareness</u> and <u>preparedness</u> by providing information describing all types of hazards, methods for preventing damage, and how to respond.
- ~~Protect critical facilities and infrastructure from natural hazards.~~
- Strengthen protection critical facilities and infrastructure from natural hazards to create a safer, more sustainable community.

Next Steps of Planning Process

Next Steps

- Review Chapters 1, 2, and 3
  - Review Risk Assessment Chapter 3 – return comments and/or track changes to DropBox site or email
  - Review Mitigation Actions from 2010 Mitigation Plan
- Amec Foster Wheeler
  - Distribute Risk Assessment Chapter 3 to Planning Committee
  - Prepare 2nd Public Outreach Flyer for upcoming meeting
- Next HMPC and Public Meeting – October 25
- Contact ANYTIME with questions or concerns

cindy.popplewell@amecfw.com
(615) 333-0630 ext. 7050
(303) 704-8939

Attachment B – Sign-In Sheets

SEPT. 26

Sign-In Sheet – ~~July 11~~, 2017

Name	Title	Department	Email	Phone
DEREK FREGEOLLE	LT., SUPPORT SERVICES	KNOX COUNTY SCHOOLS	DEREK.FREGEOLLE@KNOXSCHOOLS.ORG	203-0835
EDDY ROBERTS		KNOX COUNTY STORMWATER	eddy.roberts@knoxcounty.org	865 215-5234
David McGinley	Stormwater Engineering Man	COK	DMcGinley@KnoxvilleTN.GOV	215-2072
Keith Stump	EXEC DIRECTOR	KGIS	Kstump@kgis.org	215-3632
Zach Bonham	Planner	Town of Farragut	zbonham@townoffarragut.org	865-266-0666
Bart Hose	Planner	Town of Farragut	bhose@townoffarragut.org	865-966-7057
Becky Wade	Director, Comm. Dev	City of Knoxville	bwade@knoxvilletn.gov	865-215-2865
Erin Gill	Sustainability	City of Knoxville	egill@knoxvilletn.gov	215-4430
Lisa Hatfield	CITY LAWYER	LAW	LHATFIELD@KnoxvilleTN.GOV	215-2050
DAVID SPARKS	ASST. CITY ENGINEER	ENGINEERING	DSPARKS@TOWNOFFARRAGUT.ORG	966-7057
DAN KELLY	Deputy Director	MPC	dan.kelly@knoxmpc.org	215-3440

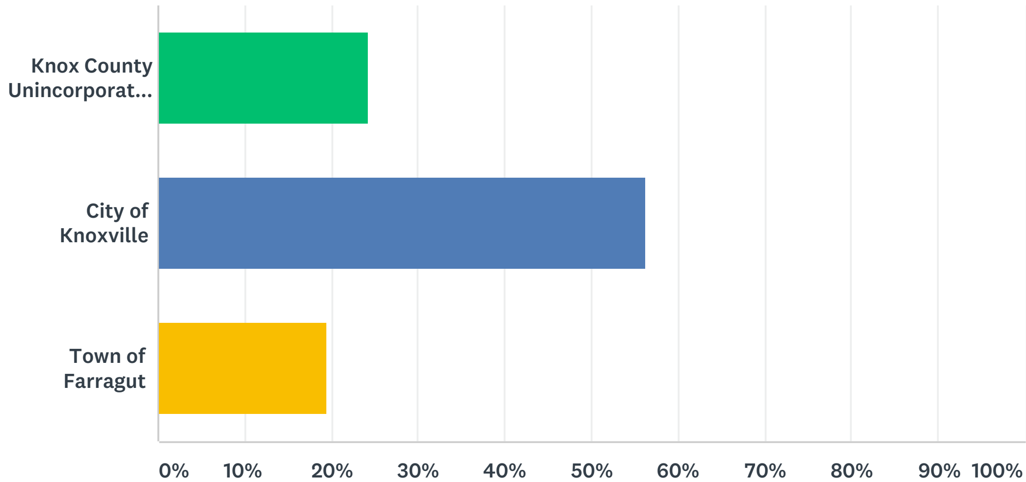
Sign-In Sheet – ~~July 11~~ Sept. 26, 2017

Name	Title	Department	Email	Phone
Eric Knoefel	CAPTAIN	Rural Metro Fire Dept.	eric.knoefel@ruralmetrofire.com	865-388-9459
John Sexton	Staff Trans. Engineer	Knox County EPW	john.sexton@knoxcounty.org	865-215-5860
Colin Ickes	Director	Emergency Management	cickes@knoxvilletn.gov	215-1166
Cathy Olsen	GIS Admin	Stormwater Manager	cathy.olsen@knoxcounty.org	2155886
Lori Saal	Stormwater Coordinator	Farragut Engineering	lsaal@townoffarragut.org	966-7057
Chris Granju	Stormwater Dir.	Knox Co. Stormwater	chris.granju@knoxcounty.org	215-5840
Judy Wasik	Operations Officer	KEMA	jwasik@knoxvilletn.gov	215-1166
Chad Weth	Director	Knoxville Public Service	cweth@knoxvilletn.gov	215-2060
Todd Napier	President	The Development Corp. of Knox County	tanapier@knoxdevelopment.org	246-2650
David Hixenbaugh	Safety	Knoxville Utilities Board	david.hixenbaugh@kub.org	558-2823
Jerry Harnish	Fire Chief	Rural Metro Fire	jerry.harnish@ruralmetrofire.com	389 1019

Attachment C – Summary of Public Survey Results

Q1 Where do you live in Knox County? Please select your location:

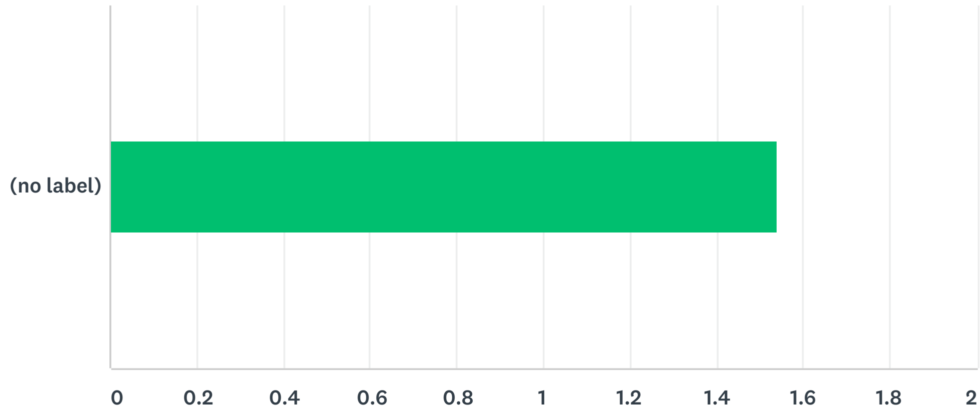
Answered: 103 Skipped: 0



ANSWER CHOICES	RESPONSES	
Knox County Unincorporated Area	24.27%	25
City of Knoxville	56.31%	58
Town of Farragut	19.42%	20
TOTAL		103

Q2 Have you ever experienced or been impacted by a disaster?

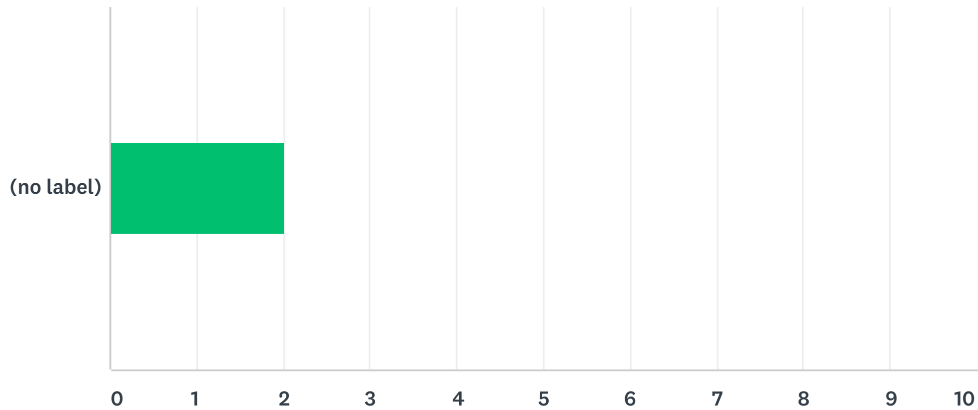
Answered: 101 Skipped: 2



	YES	NO	TOTAL	WEIGHTED AVERAGE
(no label)	45.54% 46	54.46% 55	101	1.54

Q3 How concerned are you about the possibility of being impacted by a disaster?

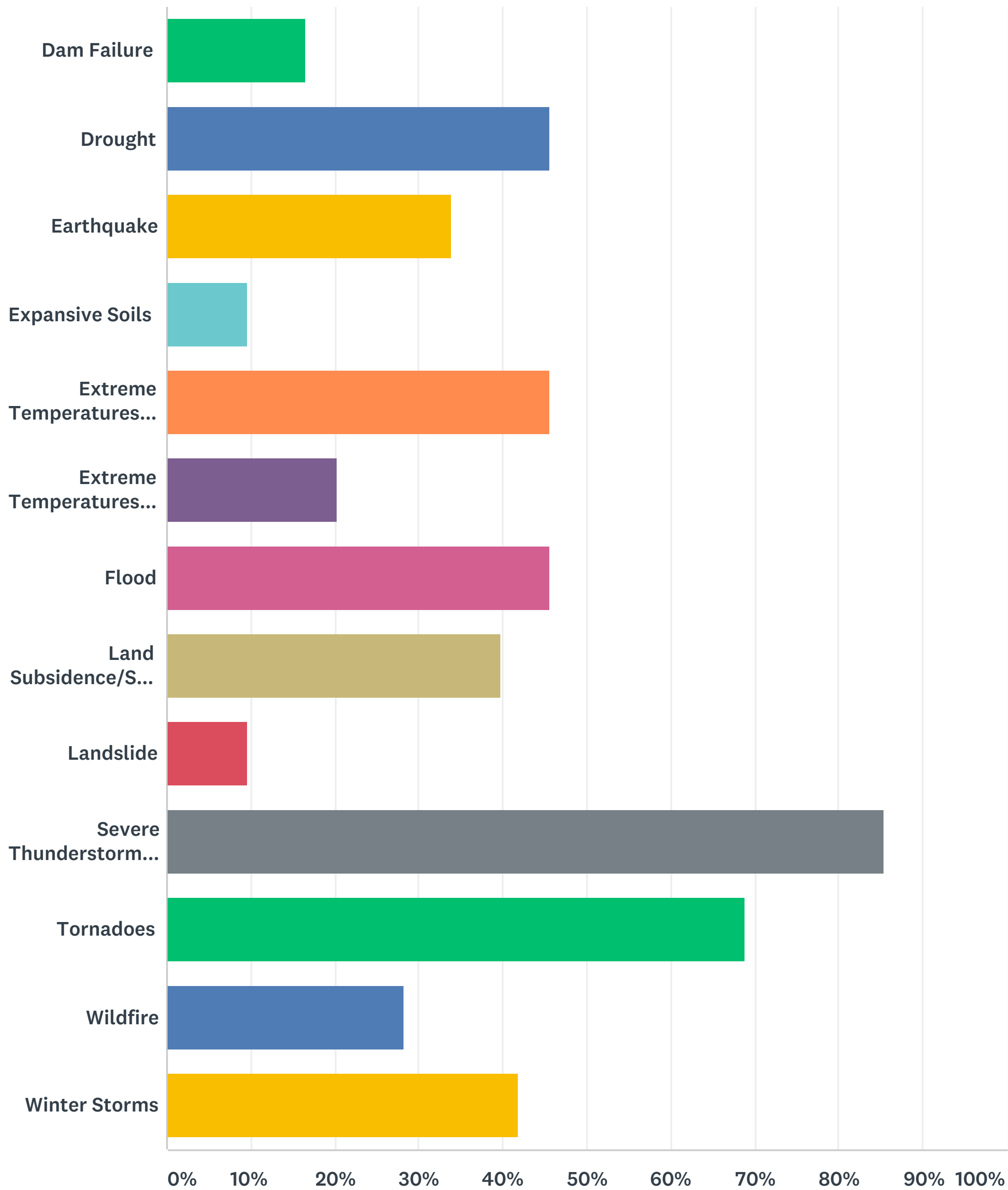
Answered: 103 Skipped: 0



	NOT CONCERNED	SOMEWHAT CONCERNED	EXTREMELY CONCERNED	TOTAL	WEIGHTED AVERAGE
(no label)	13.59% 14	71.84% 74	14.56% 15	103	2.01

Q4 What natural hazards do you feel pose a threat to you? Please check all that apply:

Answered: 103 Skipped: 0



ANSWER CHOICES	RESPONSES	
Dam Failure	16.50%	17
Drought	45.63%	47
Earthquake	33.98%	35
Expansive Soils	9.71%	10
Extreme Temperatures - High	45.63%	47

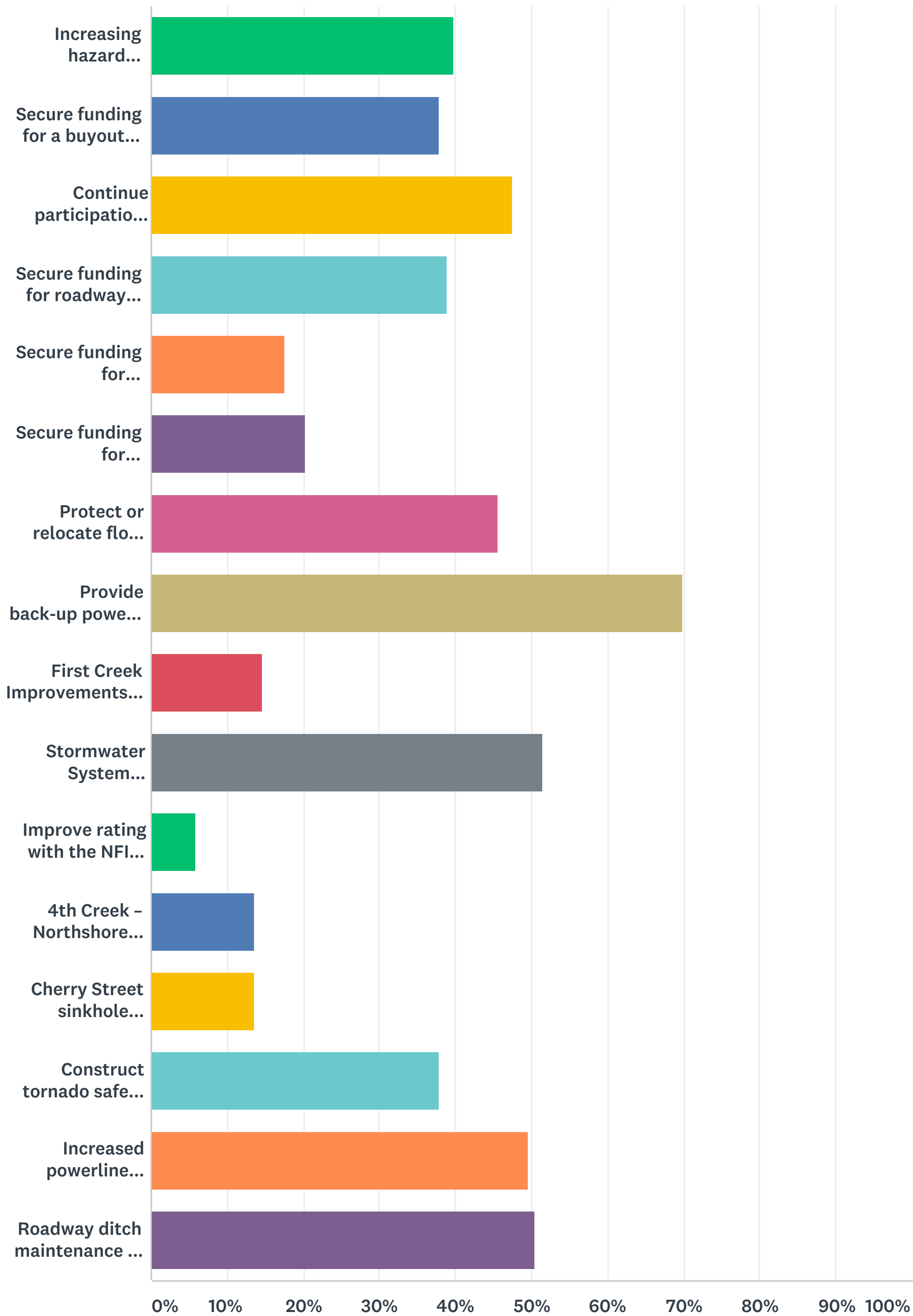
Extreme Temperatures - Low	20.39%	21
Flood	45.63%	47
Land Subsidence/Sinkholes	39.81%	41
Landslide	9.71%	10
Severe Thunderstorms/High Wind	85.44%	88
Tornadoes	68.93%	71
Wildfire	28.16%	29
Winter Storms	41.75%	43
Total Respondents: 103		

Q5 Is there another hazard, not listed above, that you think is a threat to you? Please explain:

Answered: 30 Skipped: 73

Q6 What types of mitigation actions do you think should have the highest priority?

Answered: 103 Skipped: 0



ANSWER CHOICES	RESPONSES

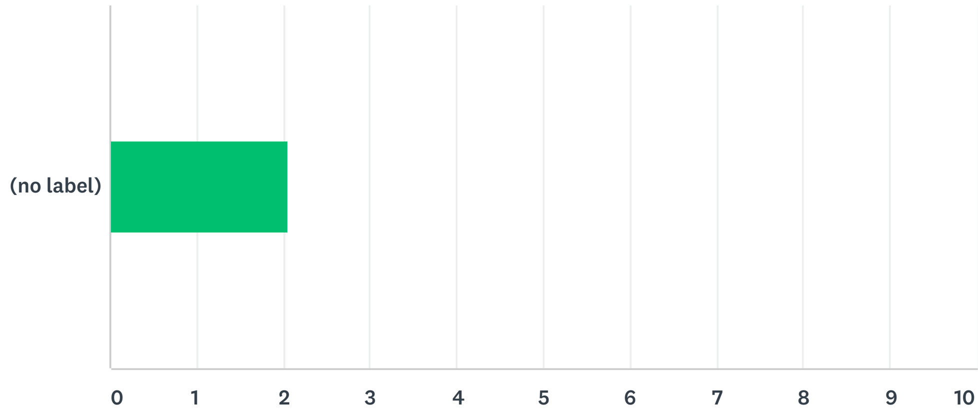
Increasing hazard education and risk awareness.	39.81%	41
Secure funding for a buyout of floodprone properties that experience repetitive flooding.	37.86%	39
Continue participation in the National Flood Insurance Program (NFIP).	47.57%	49
Secure funding for roadway improvement projects that would protect roadways from repetitive flooding.	38.83%	40
Secure funding for construction of regional detention basins.	17.48%	18
Secure funding for uninterruptible power supply battery-backup systems for traffic signals.	20.39%	21
Protect or relocate flood prone critical facilities.	45.63%	47
Provide back-up power for critical facilities (water system pumps, hospitals, nursing homes, schools, etc.)	69.90%	72
First Creek Improvements – Walker Blvd.; Grainger; North of Tecoma	14.56%	15
Stormwater System Maintenance.	51.46%	53
Improve rating with the NFIP Community Rating System	5.83%	6
4th Creek – Northshore Bridge Improvements; 4th Creek Channel Stabilization	13.59%	14
Cherry Street sinkhole maintenance	13.59%	14
Construct tornado safe rooms in public buildings including schools.	37.86%	39
Increased powerline maintenance to reduce instances of falling trees on powerlines	49.51%	51
Roadway ditch maintenance to prevent roadway flooding	50.49%	52
Total Respondents: 103		

Q7 Are there other mitigation actions Knox County, the City of Knoxville, and the Town of Farragut should consider for reducing future losses caused by natural hazards? Please explain:

Answered: 30 Skipped: 73

Q8 How prepared do you feel for a hazard event?

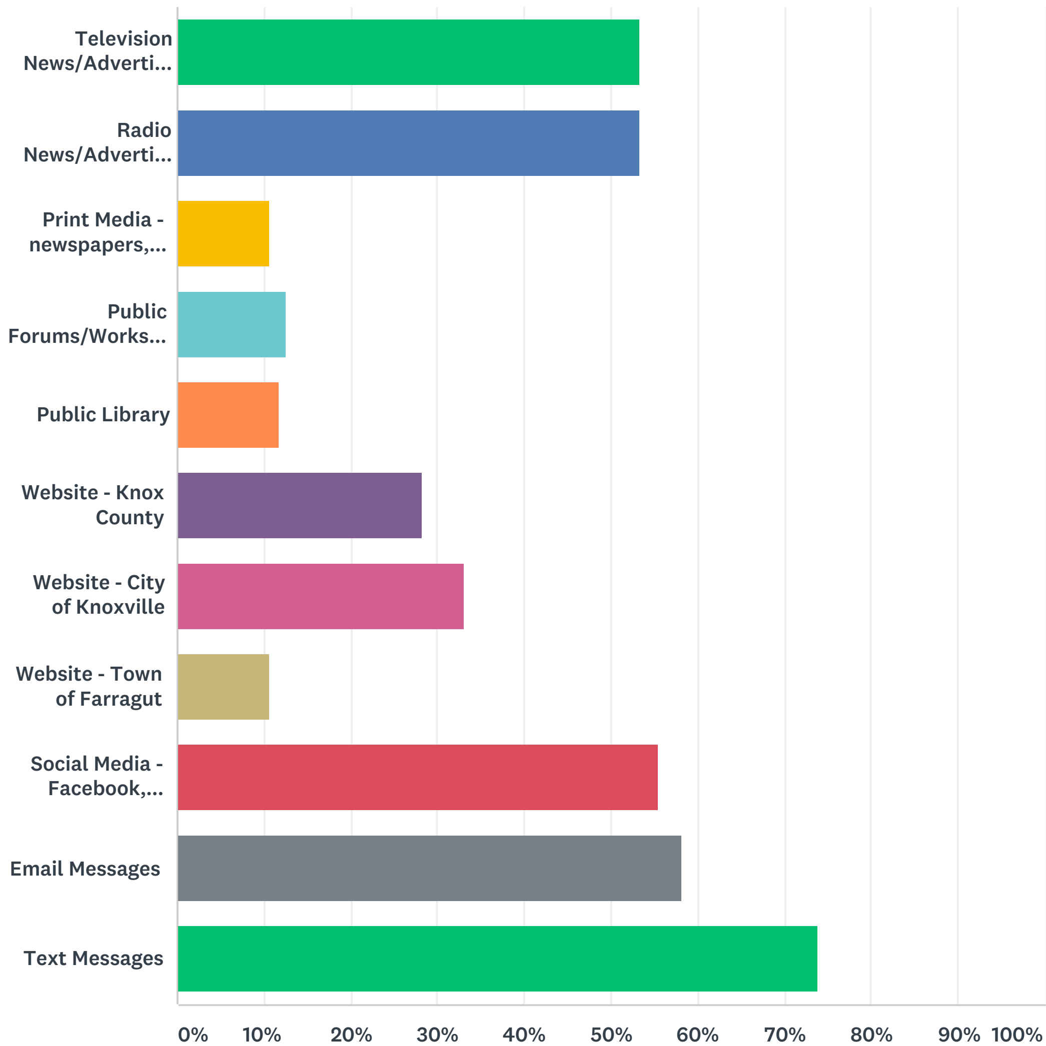
Answered: 102 Skipped: 1



	NOT AT ALL PREPARED	SOMEWHAT PREPARED	PREPARED	VERY PREPARED	TOTAL	WEIGHTED AVERAGE
(no label)	14.71% 15	67.65% 69	16.67% 17	0.98% 1	102	2.04

Q9 What is the best way for you to receive information about hazard events? Please check all that apply:

Answered: 103 Skipped: 0



ANSWER CHOICES	RESPONSES	
Television News/Advertisements	53.40%	55
Radio News/Advertisements	53.40%	55
Print Media - newspapers, telephone book, informational brochures	10.68%	11
Public Forums/Workshops	12.62%	13
Public Library	11.65%	12
Website - Knox County	28.16%	29
Website - City of Knoxville	33.01%	34
Website - Town of Farragut	10.68%	11
Social Media - Facebook, Twitter	55.34%	57

Email Messages	58.25%	60
Text Messages	73.79%	76
Total Respondents: 103		

Q10 If you would like to receive additional information on the hazard mitigation planning process, please provide your contact information:

Answered: 26 Skipped: 77

ANSWER CHOICES	RESPONSES	
Name	100.00%	26
Company	0.00%	0
Address	96.15%	25
Address 2	7.69%	2
City/Town	96.15%	25
State/Province	96.15%	25
ZIP/Postal Code	96.15%	25
Country	0.00%	0
Email Address	96.15%	25
Phone Number	80.77%	21

Memorandum

To	**Knox County, City of Knoxville, and Town of Farragut Hazard Mitigation Planning Committee (HMPC)**
From	**Cindy Popplewell**
Tel / Email	**(615) 333-0630 / cindy.popplewell@amecfw.com**
Date	**July 12, 2017**

Subject **Minutes from Multi-Hazard Mitigation Plan Kickoff Meeting**

This memorandum presents the meeting minutes from the July 11, 2017, kickoff meeting for the *Knox County, City of Knoxville, and Town of Farragut Multi-Hazard Mitigation Plan* Update. It provides an overview of natural hazard mitigation planning, identification of the planning committee, ideas for public involvement, identification of hazards affecting the communities, and next steps.

Attendees

Eddy Roberts, Knox County Engineering
David McGinley, City of Knoxville
Scott Roberts, Rural Metro Fire
Erick Knoefel, Rural Metro Fire
Brian Woods, Rural Metro Fire
Randall Whitehead, City of Knoxville
David Hixenbaugh, KUB
John Sexton, Knox County
Judy Wasik, KEMA
Bart Hose, Town of Farragut
Amy Mann, Knox County Stormwater
Becky Wade, City of Knoxville
Erin Gill, City of Knoxville
Cindy Pionke, Knox County EPW
Jimmy Brink, KGIS
Mark Shipley, Town of Farragut
Chad Weth, City of Knoxville
Chris Granju, Knox County Stormwater
Randy Lilly, Knox County
Dennis Nations, Knox County
Charissa Oglesby, City of Knoxville
David Sparks, Town of Farragut
Guy Hathaway, American Red Cross
Cindy Popplewell, Amec Foster Wheeler

Introductions

The meeting began by welcoming and thanking the attendees and introductions all around.

Overview of Hazard Mitigation Planning

Cindy Popplewell of Amec Foster Wheeler presented information on hazard mitigation, the requirements of hazard mitigation planning, and a timeline for the planning process. She explained the benefits of participating in the mitigation plan, including eligibility for federal hazard mitigation assistance. The powerpoint slide show that was used for informational purposes during the meeting is included as Attachment B.

Requirements of Hazard Mitigation Planning

Amec Foster Wheeler's approach to the planning process is structured around FEMA's four-phase guidance for developing a hazard mitigation plan: 1) organize resources, 2) assess risks, 3) develop a mitigation plan, and 4) implement the plan and monitor progress. Amec Foster Wheeler integrates the nine planning tasks identified in FEMA's March 2013 Local Mitigation Planning Handbook into these four phases. As demonstrated in the table below, the planning tasks are also consistent with FEMA's Flood Mitigation Assistance (FMA) and Community Rating System (CRS) planning process, and will thus position Knox County, City of Knoxville, and Town of Farragut to seek maximum credit under the CRS Program.

10-Step Mitigation Planning Process

FEMA 4 Phase Guidance	FEMA Local Mitigation Planning Handbook Tasks (44 CFR Part 201)	Community Rating System (CRS) Planning Steps (Activity 510)
Phase I Organize Resources	Task 1: Determine the Planning Area and Resources	Step 1. Organize to Prepare the Plan
	Task 2: Build the Planning Team 44 CFR 201.6(c)(1)	
	Task 3: Create an Outreach Strategy 44 CFR 201.6(b)(1)	Step 2. Involve the public
	Task 4: Review Community Capabilities 44 CFR 201.6(b)(2) & (3)	Step 3. Coordinate with Other Agencies
Phase II Assess Risks	Task 5: Conduct a Risk Assessment 44 CFR 201.6(c)(2)(i) 44 CFR 201.6(c)(2)(ii) & (iii)	Step 4. Assess the hazard(s)
		Step 5. Assess the problem(s)
Phase III Develop a Mitigation Plan	Task 6: Develop a Mitigation Strategy 44 CFR 201.6(c)(3)(i); 44 CFR 201.6(c)(3)(ii); and 44 CFR 201.6(c)(3)(iii)	Step 6. Set goals
		Step 7. Review possible activities
		Step 8. Draft an action plan
Phase IV Implement the Plan and Monitor Progress	Task 8: Review and Adopt the Plan	Step 9. Adopt the plan
	Task 7: Keep the Plan Current	Step 10. Implement, evaluate, revise
	Task 9: Create a Safe and Resilient Community 44 CFR 201.6(c)(4)	

Communication with the HMPC

Cindy described the role of the Hazard Mitigation Planning Committee (HMPC) during the planning process. Participation in the committee requires:

- Attending and participating in meetings,
- Providing available data requested,
- Reviewing and commenting on plan drafts,
- Advertising and assisting with the public input process, and
- Coordinating the formal adoption.

Attachment C provides an overview for HMPC members. It is anticipated that the HMPC will participate in three face-to-face hazard mitigation planning meetings. Communication between meetings will be handled primarily via email, and through Google Drive, a file-hosting service. Google Drive will be used to transfer data and publish/review draft plan chapters. Please reference the link below to access the Google Drive Project Folder:

https://drive.google.com/open?id=0Bxx8jbFUGmVsaU10dHIvbWZRUEk

Additional HMPC invitations will be extended to the Knox County School District and multiple utility providers.

Planning for Public Involvement

Potential methods for involving the public in the planning process were discussed in a tiered format geared to inform, educate, and engage the public. Initial thoughts on disseminating public information about the hazard mitigation plan and planning process included posting informational flyers to the community websites, developing a questionnaire for public input, hosting public open house meetings and coordination with the Office of Neighborhoods, and participating on the HMPC. A public outreach strategy is presented in Attachment D for review.

Risk Assessment and Capabilities Update

Amec Foster Wheeler will coordinate with the Knox County GIS staff to obtain GIS and mapping data for the risk assessment to include:

- Political boundaries
- Growth/land use maps
- Zoning data
- Parcel data
- Building footprints
- Critical facilities
- Floodplains and floodways
- Sinkhole information

Update to the Risk Assessment will include information on past occurrences, frequency/likelihood of future occurrences, and changing future conditions. Risk assessment methodologies were reviewed with recommendations for the 2017 update provided.

Attendees were also provided a data collection guide presenting information on community technical, administrative, and fiscal resources. Attendees were asked to review the data collection guide and return to Cindy Popplewell. The data collection guide is included as Attachment E.

Goals

Goals from the 2011 plan were reviewed. The HMPC attendees agreed to update the 3rd goal to reflect coordination with community sustainability goals:

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.
   REVISED AS: Strengthen protection critical facilities and infrastructure from natural hazards to create a safer, more sustainable community.

Next Steps

HMPC Members/Attendees

- Complete Data Collection Guides
- Review existing Plan and Mitigation Actions from 2011 Plan

  https://www.knoxcounty.org/stormwater/pdfs/Hazard_Mitigation_Plan.pdf

- Update website with public outreach information
- Send Letters to Other Stakeholders

Amec Foster Wheeler

- Prepare Public Outreach Strategy for review – see Attachment D
- Prepare Public Information flyer and questionnaire online for public input
- Provide template letters for Other Stakeholders
- Coordinate with GIS staffing for digital data/Risk Assessment
- Set meetings/calls with City/County Departments for Capability Assessment

Next Meeting

- September, 26th @ 2pm; City of Knoxville Public Works Large Conference Room, 3131 Morris Avenue, Knoxville, TN 37909
- This meeting will cover the update to the Hazard Risk Assessment

Attachment A – Sign-In Sheets

Meeting Sign-In Sheet

Knox County, City of Knoxville, Town of Farragut Multi-Jurisdictional Hazard Mitigation Plan Meeting

July 11, 2017, City of Knoxville Public Works Large Conference Room, 3131 Morris Ave., Knoxville, TN 37909

Name	Affiliation	Phone	E-Mail
Eddy Roberts	Knox County Eng.	865-215-5234	eddy.roberts@knoxcounty.org
David McGinley	Knox City	215-2148	DMcGinley@knoxvilletn.gov
Scott Roberts	Rural Metro Fire	865-318-3799	Scott.Roberts@ruralmetrofire.com
Eric Knoefel	Rural Metro Fire	865-388 9459	eric.knoefel@ruralmetrofire.com
Brian Woods	Rural Metro FD	865-389-4492	Brian.Woods@ruralmetrofire.com
Randall Whitehead	City of Knoxville	215-2148	R Whitehead@knoxvilletn.gov
David Hixenbaugh	Knoxville Utilities Board	865-~~228~~ 558-2823	david.hixenbaugh@kub.org
John Sexton	Knox County EMA	215-5860	john.sexton@knoxcounty.org
Judy Wasik	KEMA	215-1166	jwasik@knoxvilletn.gov
Bart Hose	Farragut	966-7057	bhose@townoffarragut.org
Amy Mann	Knox Co. Stormwater	215-5283	amy.mann@knoxcounty.org
Becky Wade	C.O.K	215-2865	bwade@knoxvilletn.gov
Erin Gill	COK	215-4430	egill@knoxvilletn.gov

Page 1 of 1

MEETING SIGN-IN SHEET

Knox County, City of Knoxville, Town of Farragut Multi-Jurisdictional Hazard Mitigation Plan Meeting

July 11, 2017, City of Knoxville Public Works Large Conference Room, 3131 Morris Ave., Knoxville, TN 37909

Name	Affiliation	Phone	E-Mail
CINDY PIONKE	KNOX COUNTY EPW	865-215-5804	CINDY.PIONKE@KNOXCOUNTY.ORG
Jimmy Brink	KGIS	865-215-3904	jbrink@kgis.org
Mark Shipley	Town of Farragut	865-966-7057	mshipley@townoffarragut.org
Chad Weth	City of Knoxville	865-215-2060	cweth@knoxvilletn.gov
Chris Granju	Knox County Stormwater	865-215-5840	chris.granju@knoxcounty.org
Randy Lilly	Knox County	865-215-2325	randy.lilly@knoxcounty.org
Dennis Nations	Knox County	865-215-2325	dennis.nations@knoxcounty.org
Charissa Oglesby	City of Knoxville	(865) 215-4321	coglesby@knoxvilletn.gov
DAVID SPARKS	TOWN OF FARRAGUT	865.966-7057	DSPARKS@TOWNOFFARRAGUT.ORG

Attachment B – Powerpoint Presentation

Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan
UPDATE
Kickoff Meeting
July 11, 2017

Cindy Popplewell
Amec Foster Wheeler
Environment & Infrastructure, Inc.

Agenda

1. **Introductions**
2. **Overview of Hazard Mitigation**
3. **Requirements of Hazard Mitigation Planning**
   - 10 Planning Steps
   - Action Items for Today
     - ✓ Finalize our Hazard Mitigation Planning Committee
     - ✓ Prepare for Public Involvement
     - ✓ Identify Data Collection Needs for Risk Assessment
     - ✓ Update Capability Assessment
4. **Timeline of Planning Process**
   - ✓ Finalize Date for next HMPC Meeting
5. **Next Steps**

Introductions

- Name
- Organization
- Hazard of Concern and/or Interest

What Is Mitigation?

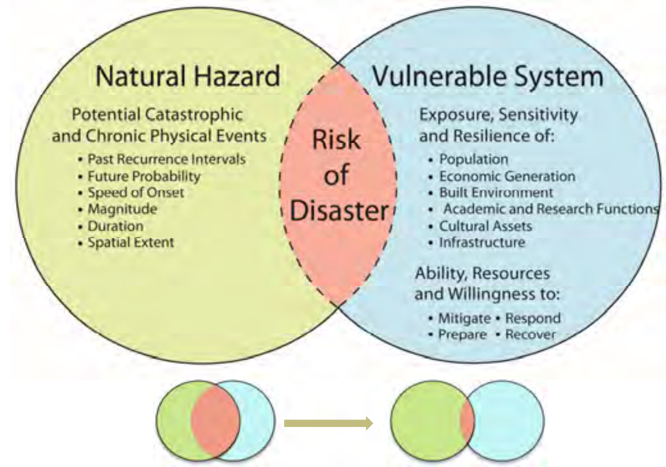
Sustained action taken to reduce or eliminate long-term risk to human life and property from natural and manmade hazards.

- Prevention
- Property Protection
- Public Education and Awareness
- Natural Resource Protection
- Emergency Services
- Structural Projects

What Is Mitigation Planning?

A process for communities to:

- Identify the natural and/or manmade hazards to which we are at risk;
- Assess the potential impacts of those hazards;
- Develop goals, objectives, and actions to reduce impacts; and
- Prioritize and implement mitigation actions.



Why Mitigation Planning?

- Increasing Cost of Disaster Response and Recovery
  - Cost of "Doing Nothing" Too Much
- Population Growth and Development
  - More People, Buildings, Infrastructure in Hazardous Areas
    - **Knox County:** 2010 - 432,226; 2016 - 456,132 **5.5%**
    - **Knoxville:** 2010 – 178,874; 2016 - 186,239 **4.4%**
    - **Farragut:** 2010 – 20,676; 2016 - 22,282 **7.6%**
- More Disaster Declarations (1953-2016)
  - Average 59 Declarations/year
  - 1990-1999 – 74/year; 2000-2010 – 124/year
  - Severe storms, flooding, hurricanes, and tornadoes
  - Billions of Tax Dollars Spent

Most Expensive Presidential Disaster Declarations

Event	Year	FEMA Funding
Hurricane Katrina (FL,LA,MS,AL)	2005	$38,318,576,948
Hurricane Sandy (NY, NJ, MD)	2012	$12,627,000,000
Attack on America - WTC (NY, NJ, VA)	2001	$8,818,350,120
Northridge Earthquake (CA)	1994	$6,978,325,877
Hurricane Rita (TX,LA)	2005	$3,749,698,351
Hurricane Ivan (LA,AL,MS,FL,NC,GA,NJ,PA,WV,NY,TN)	2004	$2,431,034,355
Hurricane Georges (AL, FL, MS, PR, VI)	1998	$2,245,157,178
Hurricane Wilma (FL)	2005	$2,110,738,364
Hurricane Charley (FL,SC)	2004	$1,885,466,628
Hurricane Andrew (FL,LA)	1992	$1,813,594,813
Hurricane Frances (FL,NC,PA,OH,NY,GA,SC)	2004	$1,773,440,505

Recent Disaster Declarations in Tennessee

Date	Disaster Type
06/23/2017	Severe Storms, Straight-Line Winds, and Flooding
12/15/2016	Wildfires
04/02/2015	Severe Winter Storm and Flooding
08/13/2014	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding
04/11/2014	Severe Winter Storm
03/16/2012	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding
07/20/2011	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding
05/09/2011	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding
05/04/2011	Flooding
05/01/2011	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding
03/31/2011	Severe Storms, Tornadoes, and Flooding
09/15/2010	Severe Storms and Flooding
05/04/2010	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding

Why Mitigation Planning?

- **Many Events are Predictable and Repetitive**
- **Loss Reduction Activities Work!**
  - A dollar spent on mitigation saves society an average of **$4.00**
  - Mitigation is sufficiently **cost-effective** to warrant federal funding on an ongoing basis both before disasters and during post-disaster recovery
  - 10 Years since Mitigation Saves, increased focus on promoting:
    - Sustainability
    - Resilience
    - Safe Growth

Why Mitigation Planning?

- **Disaster Mitigation Act of 2000**
- **Public Law 106-390; Amendment to the Stafford Act**

Requires local governments to adopt a natural hazard mitigation plan to maintain eligibility for FEMA mitigation funds:

- Hazard Mitigation Grant Program (HMGP)
- Pre-Disaster Mitigation (PDM) Program
- Flood Mitigation Assistance (FMA) Program

Requirements of Mitigation Planning

10-Step Planning Process

ORGANIZE RESOURCES

1. Get Organized
2. Plan for Public Involvement
3. Coordinate with Other Departments and Agencies

ASSESS HAZARDS AND RISK

4. Identify Hazards
5. Assess the Risks

DEVELOP MITIGATION PLAN

6. Reaffirm/Update Planning Goals
7. Review Possible Activities
8. Draft an Action Plan

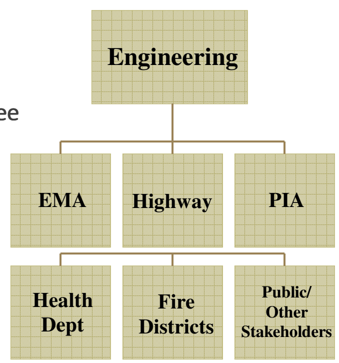
IMPLEMENT THE PLAN

9. Adopt the Plan
10. Implement the Plan, Evaluate Work, Revise as Needed

Summary of Plan Elements

1. Get Organized

- **Determine the Planning Area and Build the Planning Team**
- **Hazard Mitigation Planning Committee**
  - **Committee Members** – core group responsible for making decisions, driving the planning process, and agreeing upon the final contents of the plan
  - **Public/Other Stakeholders** – individuals or groups that affect or can be affected by a mitigation action or policy



HMPC Responsibilities

- Attending and contributing to the HMPC meetings
- Providing requested data (as available) in a timely manner
- Advertising, coordinating, and participating in public input process
- Developing and updating mitigation projects (actions)
- Reviewing and commenting on draft plan
- Coordinating formal adoption of the final plan
- Tracking time for grant reporting

1. Get Organized

✓ **Finalize our HMPC Members**

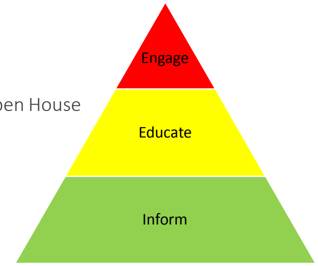
- Engineering
- Planning & Zoning
- Highway
- EMA
- Communications
- Health Department
- Fire Department/Districts
- GIS

✓ **Finalize our HMPC Stakeholders**

- American Red Cross
- Local Home Builders Association?
- Office of Education?
- Watershed Groups?
- Realtors?

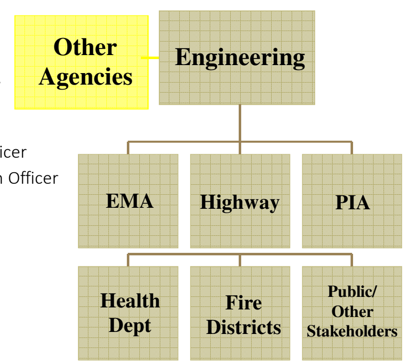
2. Plan for Public Involvement

- ENGAGE
  - Include on HMPC
- EDUCATE
  - Host Public Input Meetings/Open House
- INFORM
  - Post Data on Websites
  - Informational Flyers
    - Introduction of Planning
    - On-line Questionnaire
    - Opportunity to review draft document
- Other Outreach Ideas?



3. Coordinate with Other Departments and Agencies

- Invite to HMPC Meetings
- Request hazard data
- Send Draft Report for Review
- Identified Agencies include:
  - TEMA State Hazard Mitigation Officer
  - FEMA Region IV Hazard Mitigation Officer
  - State NFIP Coordinator
  - US Army Corps of Engineers
  - TVA
  - NRCS
  - NOAA / National Weather Service
  - Neighboring Communities



4. Identify the Hazards

- Identify all the possible hazards affecting the planning area.
- Profile the hazards
  - Hazard Description
  - Spatial Extent
  - Past Occurrences
  - Magnitude/Severity
  - Frequency/Likelihood of future occurrences
  - Changing Future Conditions
  - Define Planning Significance

Natural	
Dam Failure	Land Subsidence/ Sinkholes
Drought	Landslide
Earthquake	Severe Thunderstorms
Expansive Soils	Tornado
Extreme Temperatures	Wildfire
Flood	Winter Storms

Hazard Profiles

- Likelihood of future occurrence
  - **Highly Likely (4):** Near 100% probability in next year.
  - **Likely (3):** Between 10 and 100% probability in next year or at least one chance in ten years.
  - **Occasional (2):** Between 1 and 10% probability in next year or at least one chance in next 100 years.
  - **Unlikely (1)**: Less than 1% probability in next 100 years.
- Spatial Extent
  - **Extensive (3):** 50-100% of planning area
  - **Significant (2):** 10-50% of planning area
  - **Limited (1)**: Less than 10% of planning area
- Magnitude/Severity
  - **Catastrophic (4):** Multiple deaths, complete shutdown of facilities for 30 or more days, more than 50 percent of property is severely damaged
  - **Critical (3):** 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.
  - **Limited (2):** 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.
  - **Negligible (1):** 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

4. Identify the Hazards

Hazard	Probability	Magnitude	Spatial Extent	Planning Significance	Ranking
Flood	4	2	3	3.1	High
Extreme Temperatures	4	2	3	3.1	High
Severe Storms	4	2	3	3.1	High
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

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

5. Assess the Risk

- Inventory residential & commercial structures
- Inventory critical facilities
- Determine # and value of structures
- Determine # of people in area
- Identify vulnerable infrastructure
- Identify development trends and constraints
- Identify cultural, natural and historic resource areas
- Estimate the losses

Risk Assessment Methodology

	Vulnerability and Loss Estimation Method
Dam Failure	• 2011 - Qualitative Analysis • 2017 - Need inundation mapping for full loss estimation
Drought	• 2011 – Loss of Water Estimate ($93 per person per day) – population based • 2017 – Add crop loss estimations
Earthquake	• 2011 - HAZUS-MH Loss Estimation • 2017 – Add critical facilities; Add bridge data, as available
Extreme Temperature	• 2011 – Qualitative Analysis; Population statistics • 2017 – Add crop loss estimations
Expansive Soils	• 2011 – Qualitative Analysis • 2017 – Update qualitative analysis
Flood	• 2011 - HAZUS-MH Loss Estimation • 2017 - Incorporation of FIRM and/or Risk MAP Data, as available

Risk Assessment Methodology

	Vulnerability and Loss Estimation Method
Land Subsidence	• 2011 - GIS-based risk modeling; bldg. counts and values over known sinkholes • 2017 - GIS-based risk modeling; bldg. counts and values over known karst areas
Landslide	• 2011 - Qualitative analysis • 2017 - GIS-based risk modeling; Areas of high susceptibility and high incidence, as available
Severe Storms	• 2011 – Loss of power; Annualized property loss • 2017 – Loss of power; Updated annualized property loss
Tornadoes	• 2011 - Statistical Analysis based on housing density • 2017 – Updated Statistical Analysis based on housing density
Wildfire	• 2011 - Statistical Analysis based on previous occurrences, annualized loses • 2017 – GIS Based analysis using Wildfire Urban Interface and Intermix areas, as available
Winter Storm	• 2011 – Loss of power; Annualized property loss • 2017 – Loss of power; Updated annualized property loss

5. Assess the Risk

✓ Data Collection Needs and Source

General Mapping Data

- Parcel Data / Building Footprints / Building Values
- Repetitive Loss Structures/Areas
- Land Use/Future Planning – Documents or Digital Data
- Insurance/Claim Information
- Utility Infrastructure
- Critical Facilities

Essential Facilities	High Potential Loss Facilities	Transportation and Lifeline
• Hospitals and other medical facilities • Police stations • Fire station • Emergency Operations Centers	• Power plants • Dams/levees • Hazardous material sites • Shelters • Day care centers • Main government buildings	• Highways, bridges, and tunnels • Railroads and facilities • Bus facilities • Water treatment facilities • Natural gas facilities and pipelines • Oil facilities and pipelines • Communications facilities

5. Assess the Risk

Capability Assessment – How prepared are we now?

- Regulatory
- Administrative/Technical
- Fiscal
  - Plans, studies, ordinances, etc.
  - Codes, regulations
  - Ability to implement hazard mitigation projects
  - Gap analysis
  - Review of possible activities

✓ Data Collection Guide

✓ Interviews with individual County Departments

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
General plan		
Zoning ordinance		
Subdivision ordinance		
Growth management ordinance		
Floodplain ordinance		
Other special purpose ordinance (stormwater, steep slope, wildfire)		
Building code		Version:
BCEGS Rating		
Fire department ISO rating		Rating:
Erosion or sediment control program		
Stormwater management program		
Site plan review requirements		
Capital improvements plan		
Economic development plan		
Local emergency operations plan		
Other special plans		
Flood insurance study or other engineering study for streams		
Elevation certificates		
Other		

6-9. Develop the Mitigation Plan

- Review existing goals and objectives – update as needed
- Review existing mitigation actions – update progress
- Identify new mitigation actions to reduce vulnerability with emphasis on new and existing buildings and infrastructure
  - Who is going to do it? Responsible Department
  - When is it going to be completed? Setting timeline
  - How is it going to be financed? Potential funding sources
- Adopt the Plan

2011 Goals

- 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.
  - Strengthen protection critical facilities and infrastructure from natural hazards to create a safer, more sustainable community.

6-9. Develop the Mitigation Plan

Plan Outline

- 1.0 – Introduction and Planning Process
- 2.0 – Community Profile
- 3.0 – Risk Assessment
- 4.0 – Mitigation Strategy
- 5.0 – Plan Maintenance
- Appendices
  - References
  - Planning Process Documentation
  - Mitigation Action Alternatives
  - Adoption Documentation

10. Implement, Evaluate, and Revise

- Plan must be updated every 5 years
- Should evaluate progress for implementation every year or more often
- Identify process to incorporate plan into other plans and programs
- Describe methods to maintain public involvement – reporting on progress and publicizing successes

Timeline of Planning Process

Timeline for Planning Process

✓Set Dates for Upcoming Meetings

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Task 1: Project Kickoff	M							
Task 2: Update Hazard Identification and Risk Assessment			M					
Task 3: Risk Assessment Meeting								
Task 4: Update Capability Assessment								
Task 5: Mitigation Goals and Actions Meeting				M				
Task 6: Draft Plan and Solicit Public Comment			O	O				
Draft for Committee Review								
Incorporate Committee Comments								
Draft for Public								
Submit to TEMA/FEMA								
TEMA and FEMA Review and Comments								

Next Steps

Next Steps

- HMPC
  - Complete Data Collection Guides
  - Review existing Plan and Mitigation Actions from 2011 Plan
  - Update website with public outreach information
  - Send Letters to Other Stakeholders
- Amec Foster Wheeler
  - Prepare Public Outreach Strategy for review
  - Prepare Public Information flyer and questionnaire online for public input
  - Provide template letters for Other Stakeholders
  - Coordinate with GIS staffing for digital data/Risk Assessment
  - Set meetings/calls with City/County Departments for Capability Assessment
- Next Meeting – September
- Contact ANYTIME with questions or concerns

cindy.popplewell@amecfw.com
(615) 333-0630 ext. 7050; (303) 704-8939

Attachment C – Overview for HMPC Members

Knox County, City of Knoxville, Town of Farragut Multi-Hazard Mitigation Plan Update

Overview

Knox County is beginning the process to update the Local Hazard Mitigation Plan to better protect the people and property of Knox County from the effects of natural hazard events. The plan will be updated 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. These regulations establish the requirements that hazard mitigation plans must meet in order for the County and participating jurisdictions 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). Because the County and participating jurisdictions are subject to many kinds of hazards, access to these federal programs is vital.

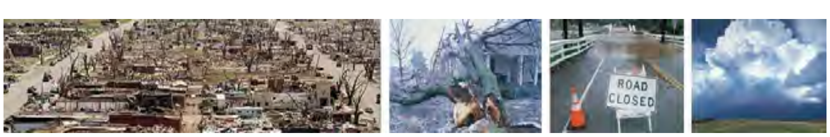
What is a Hazard Mitigation Plan?

A hazard mitigation plan is the result of a planning process which identifies policies and actions that can be implemented over the long term to reduce the risk and future losses resulting from hazard events. The Local Hazard Mitigation Plan will address a comprehensive list of natural hazards likely to impact the County and participating jurisdictions. The 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 figure to the right.

What is My Role in the Planning Process?

Knox County has contracted with Amec Foster Wheeler to facilitate the planning process and prepare the plan document. Amec Foster Wheeler's first tasks are to assist in reconvening the Hazard Mitigation Planning Committee (HMPC), as defined by the Disaster Mitigation Act (DMA), and begin preparations for a project kick-off meeting. The HMPC will include representatives from agencies involved in hazard mitigation activities, agencies with the authority to regulate development, and offices responsible for enforcing local ordinances. As a member of the HMPC, your participation in the planning process will include:

- Attending and contributing in the HMPC meetings;
- Providing requested data (as available);
- Reviewing and providing comments on plan drafts;
- Advertising, coordinating, and participating in the public input process; and



- Coordinating the formal adoption of the plan.

What can I expect for the HMPC Meetings?

In the coming months, Amec Foster Wheeler will facilitate three planning meetings with the HMPC, as briefly described below. Detailed agendas and information on the context of each meeting or activities performed within each meeting will be provided during the planning process.

- **Project Kick-off Meeting.** This meeting will initialize work with the HMPC. Amec Foster Wheeler will present information on federal planning requirements, participation requirements of HMPC members, and the proposed project work plan and schedule. A plan for public involvement and coordination with other agencies and departments will also be discussed at this initial meeting, especially regarding external agencies, such as state and federal agencies that may have significant interests (property, critical assets and infrastructure) in the County or that have information to help support the planning process. Amec Foster Wheeler will also provide follow-up interviews and data collection for development and jurisdiction profiles. Once the nucleus of the HMPC first meets at the Kickoff Meeting, it may be determined that additional representatives should be invited to participate.
- **Risk Assessment Meeting.** This meeting will include presentation of the risk assessment results and review/development of mitigation goals.
- **Mitigation Strategy Meeting.** This meeting will include updating of existing mitigation actions and identification and development of new mitigation strategies based upon the risk assessment.

Additional Resources

The following links provide additional information on hazard mitigation and the planning process.

- **Knox County's current Local Hazard Mitigation Plan**
  https://www.knoxcounty.org/stormwater/pdfs/Hazard_Mitigation_Plan.pdf

- **The requirements and procedures for state, tribal and local mitigation plans as presented in the Code of Federal Regulations (CFR) at Title 44, Chapter 1, Part 201**
  https://www.fema.gov/media-library/assets/documents/15256

- **Frequently Asked Questions regarding hazard mitigation planning**
  https://www.fema.gov/hazard-mitigation-planning-frequently-asked-questions



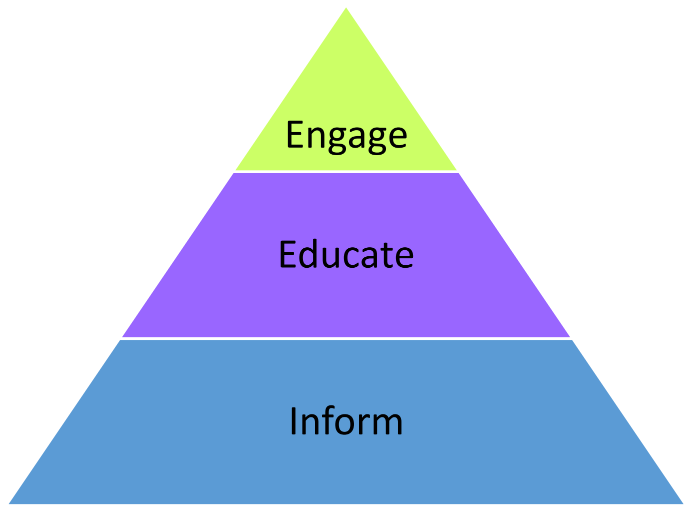
Attachment D – Public Outreach Strategy

PUBLIC OUTREACH STRATEGY

The goal of this Public Outreach Strategy is to **engage, educate, and inform** the citizens of Knox County, the City of Knoxville, and Town of Farragut of local multi-hazard mitigation planning efforts to better protect the people and property of the communities from the effects of natural hazard events. Public involvement in the planning efforts is key in developing a plan that reflects the community's values and priorities, results in a greater success rate of mitigation action implementation, and ultimately creates a safer, more disaster-resilient community.

This Public Outreach Strategy identifies the outreach tools and activities for each of the major phases of the mitigation planning process which:

- **Engage** the public and other stakeholders through interactive dialogue including such forums as planning committee meetings, public meetings, workshops and open house events;
- **Educate** the public and other stakeholders through a listen and learn process such as neighborhood association presentations, information booths, and briefings to elected officials; and
- **Inform** the public and other stakeholders through one-way communication such as written outreach materials, websites, and news media.



ENGAGE

- **Participation on the Hazard Mitigation Planning Committee (HMPC) –** Representatives of the public and stakeholders of Knox County, the City of Knoxville, and Town of Farragut will be invited to participate on the HMPC. This may includes representation from: American Red Cross, Home Builders Associations, Farm Bureau, State NFIP Coordinator, etc.

- **Public Meetings -** Two (2) public meetings will be scheduled at key points in the project timeline to obtain public input on natural hazards, problems, and possible solutions. Meetings will be held at the completion of the draft risk and capability assessments and following development of mitigation actions. These meetings will be coordinated and arranged by Knox County, the City of Knoxville, and Town of Farragut with facilitation support from Amec Foster Wheeler.

For additional information, please contact:
Eddy Roberts, Knox County
Stormwater Department,
eddy.roberts@knoxcounty.org, (865) 215-5234

EDUCATE

- **Presentations for Stakeholder Groups –** Knox County, the City of Knoxville, and Town of Farragut staff will coordinate additional hazard mitigation presentations for various stakeholder groups to explain the planning process and encourage input to the HMPC. Identified stakeholder meetings include:
  - TBD
  - Neighborhood Meetings?

- **Briefings to Elected Officials –** Knox County, the City of Knoxville, and Town of Farragut staff will coordinate one-on-one meetings with County Board Representatives and/or elected officials, upon request, to provide updates on the mitigation planning process.

- **Questionnaire -** A public participation questionnaire will be prepared by Amec Foster Wheeler using the SurveyMonkey web hosting service and will be open to the public for two months. The purpose of this questionnaire is to solicit input from the public and stakeholders in Knox County, the City of Knoxville, and Town of Farragut staff regarding hazards of concern, areas of mitigation interest, and related preparedness. The online survey will give individuals that are unable to attend the in-person meetings the opportunity to participate in the planning process. The questionnaire will be made available through web links posted on the project information website, circulated via email, and social media outlets. Additionally, hard copies of the questionnaire will be distributed at all public meetings and presentations to stakeholders groups. The feedback received will be evaluated and incorporated into the Hazard Mitigation Planning Committee's decision making process and the final Multi-Hazard Mitigation Plan.

INFORM

- **Television and Newspaper Articles –** Through coordination with the community Public Information Officers, each HMPC and Public Meeting will be announced through press releases to generate interest and support from local television stations and newspapers.

- **Public Access Television –** Powerpoint presentations from the public meetings (2) will be presented on the local public access television channel to provide an overview of hazard mitigation planning and the planning process underway.

- **Website -** A project information website will be hosted by Knox County and will be available to the general public and to members of the Hazard Mitigation Planning Committee for the duration of the planning process with the primary purpose to share information relevant to the Multi-Hazard Mitigation Plan 2017 Update. Specific resources to be included on this site include:
  - Meeting schedule, agendas, presentations, and minutes;
  - Project information flyers (3) for introduction, risk assessment, and notification of draft document;
  - Link to online questionnaire



- Draft Multi-Hazard Mitigation Plan for review/comment; and
- Reference documents and links to planning resources.

The website address is: https://www.knoxcounty.org/stormwater/fema_mitigation.php

- **Project Information Flyers –** Three (3) project information flyers will be developed and distributed throughout the planning process to provide information on the hazard mitigation planning and opportunities for public involvement. This resource will be available on the project information website as well as hard copies distributed to local libraries and public meetings identified in the 'educate' process. Specific information to be provided in the flyers includes:
  - What is a Hazard Mitigation Plan?
  - Why is it important to me?
  - What can I do to participate?
  - Planning Status
  - Mitigation Success Stories

- **Social Media –** Knox County, the City of Knoxville, and Town of Farragut County's social media outlets on Twitter and Facebook will be utilized to publish information regarding public meetings, the online questionnaire, and general hazard mitigation planning information.

For additional information, please contact:
Eddy Roberts, Knox County
Stormwater Department,
eddy.roberts@knoxcounty.org, (865) 215-5234

Attachment E – Data Collection Guide

Multi-Jurisdictional

Hazard Mitigation Plan

Data Collection Guide

For Local Governments

County: Knox County, Tennessee

Jurisdiction: ______________________________

Return by: July 28, 2017

Amec Foster Wheeler Environment & Infrastructure, Inc.

Please complete this data collection guide as accurately and completely as possible as this information will appear in the mitigation plan. A data collection guide must be completed for each "jurisdiction" that wishes to be included in the plan. According to FEMA's definition, a jurisdiction is any local government, including counties, municipalities, cities, towns, school districts, special districts, councils of government, publicly funded colleges and universities, and tribal organizations. Any of these entities that do not participate in the planning process **will not** be eligible applicants for FEMA mitigation funding programs.

Prepared by: ______________________________
Phone: ______________________________
E-mail: ______________________________
Date: ______________________________

Please return worksheets by mail or e-mail to:

Cindy Popplewell
Amec Foster Wheeler
Environment & Infrastructure, Inc.
3800 Ezell Road, Suite 100
Nashville, TN 37211
Email: cindy.popplewell@amecfw.com
Phone: 615-333-0630

amec foster wheeler

CAPABILITY ASSESSMENT
&
INCORPORATION OF EXISTING PLANS, STUDIES, REPORTS AND TECHNICAL INFORMATION

The purpose of this section is to collect information to document existing capabilities as well as determine existing plans, studies, reports, and technical information that may need to be incorporated in the mitigation plan. Although some of this information may have been captured in your previous mitigation plan, it is important to ensure this information is current in the plan update.

Please indicate which of the following your jurisdiction has in place. For elements that do not pertain to your type of public entity, please indicate with "N/A". If applicable, please provide a completion date for the element. If your jurisdiction does not have an element, and a higher level of government has the authority pertaining to your jurisdiction, please indicate this in the comments column.

2.1.1 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. Table 2.6 outlines Knox County personnel resources in 2011.

Table 2.6 Knox County Administrative and Technical Resources

Personnel Resources	Yes/No	Department/Position	UPDATE
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, Engineering & Public Works Dept., Stormwater Engineering Division	
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.

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments	UPDATE
PLANS			
General Plan	YES		
Capital improvements plan	YES		
Economic development plan	YES		
Other special plans (i.e. flood mitigation plan)	YES		
Flood insurance study or other engineering study for streams	YES		
Elevation certificates	YES		
Local emergency operations plan	YES - Part of Knox County EMA Plan		
Builder's Plan			
Local Recovery Plan			
County Recovery Plan			
Debris Management Plan			
Transportation Plan			
Land-use Plan			
Flood Mitigation Assistance (FMA) Plan			
Watershed Plan			
Firewise or other fire mitigation plan			
Critical Facilities Plan (Mitigation/Response/Recovery)			
POLICIES/ORDINANCES			
Zoning ordinance	YES		
Subdivision ordinance	YES		
Growth management ordinance	YES		
Floodplain ordinance	YES		
Other special purpose ordinance (stormwater, steep slope, wildfire)	YES		
Historic Preservation Ordinance			
Landscape Ordinance			
Building code	YES		

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments	UPDATE
BCEGS Rating	YES	3-Commercial and 4-Residentail	
Fire department ISO rating	YES	Ratings:4-6 (varies across county)	
PROGRAMS			
Erosion or sediment control program	YES		
Stormwater management program	YES		
Site plan review requirements	YES		
Hazard Awareness/Public Education Program			
National Flood Insurance Program			
Community Rating System (CRS) program under the National Flood Insurance Program (NFIP)?			
National Weather Service (NWS) Storm Ready Certification			
Economic Development Program			
Land-use Program			
Property Acquisition			
Planning/Zoning Boards			
Stream Maintenance Program			
Tree Trimming Program			
Mutual Aid Agreements			
Stream Maintenance Program			
STUDIES/REPORTS/MAPS			
Hazard Analysis/Risk Assessment (City)			
Hazard Analysis/Risk Assessment (County)			
Evacuation Route Map			
Critical Facilities Inventory			
Vulnerable Population Inventory			
Land-use Map			

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.
- Knox county Air Quality Management Department also has programs , such as, Air Now, Spare the Air, SunWise, and other public outreach programs.

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.

2.1.2 City of Knoxville

The City of Knoxville 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. The City of Knoxville mitigation capabilities 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 the City of Knoxville.

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:

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

KEMA	Water Quality Hotline
KCDC	World's Fair Park Zoo
Knoxville Utilities Board	

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. Table 2.8 outlines the City's personnel resources in 2011.

Table 2.8 Knoxville's Administrative and Technical Resources

Personnel Resources	Yes/No	Department/Position	UPDATE
Planner/Engineer with knowledge of land development/land management practices	YES	Knoxville-Knox County Metropolitan Planning Commission, City of Knoxville Public Works	
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	YES	City of Knoxville Engineering Department	
Planner/Engineer/Scientist with an understanding of natural hazards	YES	Knoxville-Knox County Metropolitan Planning Commission, City of Knoxville Public Works	
Personnel skilled in GIS	YES	Knoxville-Knox County Metropolitan Planning	
Full time building official	YES	Public Works Dept., Plans Review & Inspections	
Floodplain Manager	YES	Engineering Dept., Stormwater	
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 2007 International Code Council. 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	UPDATE
PLANS		
General Plan	YES	
Capital improvements plan	YES	
Economic development plan	YES	
Other special plans (i.e. flood mitigation plan)	YES	
Flood insurance study or other engineering study for streams	YES	
Elevation certificates	YES	
Local emergency operations plan	YES - Part of Knox County EMA Plan	
Builder's Plan		
Local Recovery Plan		
County Recovery Plan		
Debris Management Plan		
Transportation Plan		
Land-use Plan		
Flood Mitigation Assistance (FMA) Plan		
Watershed Plan		
Firewise or other fire mitigation plan		
Critical Facilities Plan (Mitigation/Response/Recovery)		
POLICIES/ORDINANCES		
Zoning ordinance	YES	
Subdivision ordinance	YES	

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments	UPDATE
Growth management ordinance	NO	Growth policy plan but no	
Floodplain ordinance	YES		
Other special purpose ordinance (stormwater, steep slope, wildfire)	YES		
Historic Preservation Ordinance			
Landscape Ordinance			
Building code	YES		
BCEGS Rating			
Fire department ISO rating	3		
PROGRAMS			
Erosion or sediment control program	YES		
Stormwater management program	YES		
Site plan review requirements	YES		
Hazard Awareness/Public Education Program			
National Flood Insurance Program			
Community Rating System (CRS) program under the National Flood Insurance Program (NFIP)?			
National Weather Service (NWS) Storm Ready Certification			
Economic Development Program			
Land-use Program			
Property Acquisition			
Planning/Zoning Boards			
Stream Maintenance Program			
Tree Trimming Program			
Mutual Aid Agreements			
Stream Maintenance Program			
STUDIES/REPORTS/MAPS			
Hazard Analysis/Risk Assessment (City)			
Hazard Analysis/Risk Assessment (County)			
Evacuation Route Map			
Critical Facilities Inventory			
Vulnerable Population Inventory			
Land-use Map			

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 SafetyCity where every 2nd-grade child learns traffic and personal safety from the Knxoville 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: LifeSkills 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.

2.2.2 Town of Farragut

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. The Town of Farragut mitigation capabilities 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 the 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	KGIS
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 2

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	UPDATE
PLANS		
General Plan	YES - Land Use and Transportation Plan	
Capital improvements plan	YES	
Economic development plan	YES	
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	
Local emergency operations plan	YES - Part of Knox County EMA Plan	
Builder's Plan		
Local Recovery Plan		
County Recovery Plan		
Debris Management Plan		
Transportation Plan		
Land-use Plan		
Flood Mitigation Assistance (FMA) Plan		
Watershed Plan		
Firewise or other fire mitigation plan		
Critical Facilities Plan (Mitigation/Response/Recovery)		
POLICIES/ORDINANCES		
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.	
Historic Preservation Ordinance		
Landscape Ordinance		
Building code	YES	
BCEGS Rating	3	
Fire department ISO rating	3	

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments	UPDATE
PROGRAMS			
Erosion or sediment control program	YES		
Stormwater management program	YES		
Site plan review requirements	YES		
Hazard Awareness/Public Education Program			
National Flood Insurance Program			
Community Rating System (CRS) program under the National Flood Insurance Program (NFIP)?			
National Weather Service (NWS) Storm Ready Certification			
Economic Development Program			
Land-use Program			
Property Acquisition			
Planning/Zoning Boards			
Stream Maintenance Program			
Tree Trimming Program			
Mutual Aid Agreements			
Stream Maintenance Program			
STUDIES/REPORTS/MAPS			
Hazard Analysis/Risk Assessment (City)			
Hazard Analysis/Risk Assessment (County)			
Evacuation Route Map			
Critical Facilities Inventory			
Vulnerable Population Inventory			
Land-use Map			

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.

Additional Questions

1. How is your government structure organized? (e.g. Commission, Mayor/City Council, how many members, etc.)

2. List any past or ongoing public education or information programs, such as for responsible water use, fire safety, household preparedness, or environmental education.

3. List any other past or ongoing projects or programs designed to reduce disaster losses. These may include projects to protect critical facilities. Be sure to include pending or approved projects submitted for FEMA mitigation grants.

4. Describe any hazard-related concerns or issues regarding the vulnerability of special needs populations, such as the elderly, disabled, low-income, or migrant farm workers.

5. Does your community have outdoor warning sirens?

   If so, how many?

   How are they activated (indicate responsible department/personnel)?

6. Does your community utilize any other warning systems such as Cable Override, Reverse 911, etc? If so, please describe.

7. Does your community have designated public tornado shelters/saferooms? If so, are they constructed in accordance with FEMA standards?

   Please provide address locations:

8. Describe general development trends that have occurred in the last 5 years in your jurisdiction.

9. Describe future development plans and expected growth areas. Is any new development expected to occur in the 100-year floodplain? Is any new development expected to occur in any other known hazard areas? If possible, please provide a map indicating potential/planned growth areas.

10. Are any new facilities or infrastructure planned for construction during the next five years? If so, please provide facility name and purpose along with proposed locations, if known.

11. Please list major employers in your jurisdiction with an estimated number of employees.

Knox County, City of Knoxville, and Town of Farragut Multi-Hazard Mitigation Plan - Public Questionnaire

Knox County, the City of Knoxville, and the Town of Farragut are beginning the process to update the Multi-Hazard Mitigation Plan to better protect the people and property of the communities from the effects of natural hazard events. As a part of the planning process, we would like your input to better understand hazard concerns and preparedness.

BACKGROUND INFORMATION

1. Where do you live in Knox County? Please select your Township:
   - ☐ Knox County Unincorporated Area
   - ☐ City of Knoxville
   - ☐ Town of Farragut

HAZARD IDENTIFICATION

2. Have you ever experienced or been impacted by a disaster?
   - ☐ Yes
   - ☐ No

3. How concerned are you about the possibility of being impacted by a disaster?
   - ☐ Extremely concerned
   - ☐ Somewhat concerned
   - ☐ Not concerned

4. What natural hazards do you feel pose a threat to Knox County? Please check all that apply.
   - ☐ Dam Failure
   - ☐ Drought
   - ☐ Earthquake
   - ☐ Expansive Soils
   - ☐ Extreme Temperatures – High
   - ☐ Extreme Temperatures – Low
   - ☐ Flood
   - ☐ Land Subsidence/Sinkholes
   - ☐ Landslide
   - ☐ Severe Thunderstorms/High Wind
   - ☐ Tornadoes
   - ☐ Wildfire
   - ☐ Winter Storms

5. Is there another hazard, not listed above, that you think is a wide-scale threat to Knox County? Please explain:

PREPAREDNESS

6. How prepared do you feel for a hazard event?
   - ☐ Not at all prepared
   - ☐ Somewhat prepared
   - ☐ Prepared
   - ☐ Very prepared

MITIGATION ACTIONS

7. What types of mitigation actions should have the highest priority?
   - ☐ Increase hazard education and risk awareness
   - ☐ Secure funding for a buyout of flood prone properties that experience repetitive flooding.
   - ☐ Continue Participation in the National Flood Insurance Program (NFIP)*
   - ☐ Secure funding for roadway improvement projects that would protect roadways from repetitive flooding.
   - ☐ Secure funding for construction of regional detention basins.
   - ☐ Secure funding for uninterruptible power supply battery-backup systems for traffic signals.
   - ☐ Protect or relocate flood prone critical facilities.
   - ☐ Provide Back-up power for critical facilities (water system pumps, hospitals, nursing homes, schools, etc.)
   - ☐ First Creek Improvements – Walker Blvd.; Grainger; North of Tecoma
   - ☐ Stormwater System Maintenance.
   - ☐ Improve NFIP Community Rating System*
   - ☐ 4th Creek – Northshore Bridge Improvements; 4th Creek Channel Stabilization
   - ☐ Cherry Street Sinkhole Maintenance
   - ☐ Construct tornado safe rooms in public buildings including schools.
   - ☐ Increased powerline maintenance to reduce instances of falling trees on powerlines
   - ☐ Roadway ditch maintenance to prevent roadway flooding

8. Are there other mitigation actions Knox County, the City of Knoxville, and the Town of Farragut should consider for reducing future losses caused by natural or man-made hazards? Please explain:

9. What is the best way for you to receive information about hazard events? Please check all that apply.
   - ☐ Television News/Advertisements
   - ☐ Radio News/Advertisements
   - ☐ Print Media – newspaper, telephone book, informational brochures
   - ☐ Public Forums/Workshops
   - ☐ Public Library
   - ☐ Website
   - ☐ Social Media – Facebook, Twitter
   - ☐ Email messages
   - ☐ Text Messages

FUTURE UPDATES

10. If you would like to receive any additional information on the hazard mitigation planning process, please provide your email address:

THANK YOU FOR YOUR PARTICIPATION!

Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan Update

Knox County, the City of Knoxville, and Town of Farragut are beginning the process to update the Multi-Jurisdictional Local Hazard Mitigation Plan to better protect the people and property of the communities from the effects of natural hazard events and to obtain eligibility for mitigation funding from the Federal Emergency Management Agency (FEMA).

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 and earthquakes to tornadoes, and severe winter weather. The plan will assess the likely impacts of these hazards to the unincorporated areas of Knox County, the City of Knoxville, and the Town of Farragut. 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.

Phase I
- 1. Organize Planning Team
- 2. Plan for Public Involvement
- 3. Coordinate with Other Departments/Agencies

Phase 2
- 4. Identify the Hazards
- 5. Estimate Losses

Phase 3
- 6 Identify Goals and Objectives
- 7. Develop Potential Mitigation Actions
- 8. Draft the Mitigation Plan

Phase 4
- 9. Adopt the Plan
- 10. Implement and Maintain the Plan

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?

- The planning team would like your input on a public survey. This survey captures public opinion on the hazards that are the most significant to you as well as the types of activities that you think will help prevent or reduce losses: **www.surveymonkey.com/r/Knox_Mitigation**
- Additionally, an Public Meeting will be held on September 26th to get kickoff the planning process with the public and stakeholders:
  5:00 – 7:00pm Tuesday, September 26, 2017
  Public Works Service Center, Large Conference Room
  3131 Morris Ave, Knoxville, TN 37909

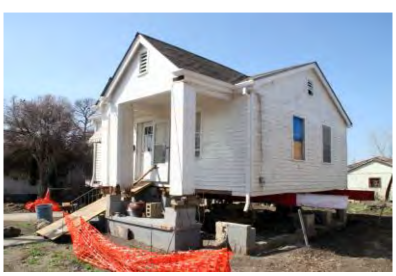


Photo Source: FEMA

Planning Status

The planning team is currently working within Phase 1: Organize Resources. On July 11, 2017, the planning team held a kick-off meeting to organize the planning effort, plan for public involvement opportunities and initiate coordination with other departments and agencies.

Implementation of the Plan is the Ultimate Goal!

The ultimate goal of this planning process is implementation of mitigation actions that will prevent or lessen the impacts of hazards to people and property in your community. An example is the elevation of structures that repeatedly flood, reducing structural damage in the event of future flooding.

For more information please contact David Sparks
at (865) 966-7057 or dsparks@townoffarragut.org

Memorandum

To	**Knox County, City of Knoxville, and Town of Farragut Hazard Mitigation Planning Committee (HMPC)**
From	**Cindy Popplewell**
Tel / Email	**(615) 333-0630 / cindy.popplewell@amecfw.com**
Date	**October 25, 2017**
Subject	**Minutes from Multi-Hazard Mitigation Plan – Mitigation Action Meeting**

This memorandum presents the meeting minutes from the October 25, 2017, mitigation action meeting for the *Knox County, City of Knoxville, and Town of Farragut Multi-Hazard Mitigation Plan* Update. It provides an update on the planning progress; updates on the hazard risk assessment; review and identification of mitigation actions and next steps. The powerpoint presentation is included as Appendix A.

Attendees

Erick Knoefel, Rural Metro Fire
Brian Woods, Rural Metro Fire
John Sexton, Knox County
Colin Ickes, KEMA
Cathy Olsen, GIS Admin
Lori Saal, Stormwater Coordinator
Chris Granju, Knox County Stormwater
Todd Napier, Development Corp of Knox Co
David Hixenbaugh, KUB
Eddy Roberts, Knox County Engineering
David McGinley, City of Knoxville
Bart Hose, Town of Farragut
Erin Gill, City of Knoxville
Lisa Hatfield, City Lawyer
Amy Mann, Knox County Stormwater
David Hagerman, City of Knoxville Engineering
David Sparks, Town of Farragut
Dan Kelly, MPC
Cindy Popplewell, Amec Foster Wheeler

A copy of the sign-in sheet is included in Appendix B.

Introductions

The meeting began by welcoming and thanking the attendees and introductions all around.

Update on Hazard Mitigation Planning Progress

Amec Foster Wheeler's approach to the planning process is structured around FEMA's four-phase guidance for developing a hazard mitigation plan: 1) organize resources, 2) assess risks, 3) develop a mitigation plan, and 4) implement the plan and monitor progress. Amec Foster Wheeler integrates the nine planning tasks identified in FEMA's March 2013 Local Mitigation

Planning Handbook into these four phases. As demonstrated in the table below, the planning tasks are also consistent with FEMA's Flood Mitigation Assistance (FMA) and Community Rating System (CRS) planning process, and will thus position Knox County, City of Knoxville, and Town of Farragut to seek maximum credit under the CRS Program. Current planning progress is presented in red text in the table below:

10-Step Mitigation Planning Process

FEMA 4 Phase Guidance	FEMA Local Mitigation Planning Handbook Tasks (44 CFR Part 201)	Community Rating System (CRS) Planning Steps (Activity 510)
Phase I Organize Resources	Task 1: Determine the Planning Area and Resources	Step 1. Organize to Prepare the Plan Completed
	Task 2: Build the Planning Team 44 CFR 201.6(c)(1)	
	Task 3: Create an Outreach Strategy 44 CFR 201.6(b)(1)	Step 2. Involve the public Ongoing with flyers, survey, and public meetings
	Task 4: Review Community Capabilities 44 CFR 201.6(b)(2) & (3)	Step 3. Coordinate with Other Agencies Completed
Phase II Assess Risks	Task 5: Conduct a Risk Assessment 44 CFR 201.6(c)(2)(i) 44 CFR 201.6(c)(2)(ii) & (iii)	Step 4. Assess the hazard(s) Completed
		Step 5. Assess the problem(s) Completed
Phase III Develop a Mitigation Plan	Task 6: Develop a Mitigation Strategy 44 CFR 201.6(c)(3)(i); 44 CFR 201.6(c)(3)(ii); and 44 CFR 201.6(c)(3)(iii)	Step 6. Set goals Completed
		Step 7. Review possible activities Discussion Today
		Step 8. Draft an action plan Discussion Today
Phase IV Implement the Plan and Monitor Progress	Task 8: Review and Adopt the Plan	Step 9. Adopt the plan
	Task 7: Keep the Plan Current	Step 10. Implement, evaluate, revise
	Task 9: Create a Safe and Resilient Community 44 CFR 201.6(c)(4)	

Hazard Identification and Risk Assessment

Based on input at the previous HMPC meeting, the following updated hazard information was presented:

- Earthquake – The probability was updated from “likely” to “occasional” based upon the number of occurrences of earthquakes with a magnitude greater than 3.0. This updated probability raking drops the overall planning significance from Medium to Low.

- Flood – HAZUS results were presented along with mapping related to drainage complaints.

- Land Subsidence/Sinkholes – Hazard description was updated to include causes for subsidence as (1) Compaction of aquifer systems; (2) Drainage and subsequent oxidation of organic soils; and (3) Dissolution and collapse of susceptible rocks – or sinkholes, with sinkholes as the focus for the risk assessment.

- Wildfire – Data from the Tennessee Fire Incident Reporting System (TN FIRS) was presented. The HMPC discussed focusing inclusion of data for forest/wood/wildland fire as the most applicable for the wildfire hazard. Incidents noted as brush, grass, or natural vegetation did not reflect the characteristics of a wildfire, incorporating too many occurrences of small scale, localized events.

The first draft of Chapter 3 is now available for review here:

- https://www.dropbox.com/s/iuh8vv19u053bw4/DRAFT_Knox_Co_HMP_3.docx?dl=0

Develop Mitigation Actions

Mitigation actions are developed to reduce losses before a disaster occurs. Mitigation actions have long-term and cumulative benefits. Some mitigation actions are identified and prioritized because they are low cost or readily implemented. Other mitigation actions may be dependent on funding or are best implemented following a disaster.

Mitigation actions identified by the HMPC include:

1. Amplify outreach/public education to encourage participation in Reverse 911 system.
2. Create and/or update existing KEMA fact sheets for natural hazards to define hazard risks and suggest personal mitigation actions.
3. Provide educational workshop and/or informational materials for the real estate industry including buyers, agents, and lenders.
4. Real estate disclosure to buyer of drainage easement maintenance responsibility. (Also, detention ponds, low impact development practices, etc.) Realtors Board, all governing agencies
5. Develop outreach/public education program to address excessive heat, sheltering options, and information on reducing agricultural losses
6. Develop outreach/public education program for defensible space for wildfire

7. Pursue funding for back-up power generators for identified critical facilities and infrastructure.
8. Develop MOU for sharing community resources, in addition existing emergency response resources and capabilities.
9. Review fuel supply and storage capabilities at critical facilities to ensure continuity of operations during a hazard event.
10. Review potential for enhancement to existing warning system(s); identify methods for targeting vulnerable populations
11. Secure funding for uninterruptible power supply battery-backup systems for traffic signals
12. Implement and Maintain the Knoxville-Knox County Excessive Heat Plan seeking partners to add/refine response options and incorporating public comment and participation
13. Encourage underground utilities for new development
14. Continue participation in the National Flood Insurance Program (NFIP)
15. Participate in the NIFP Community Rating System (CRS) users group, seeking continued improvement in CRS rating
16. Review opportunities to regulate private maintenance of stormwater systems conveyance and storage
17. Research options to develop open space preservation policy, especially in streamside areas
18. Research opportunities to implement more stringent requirements for low-impact development practices for new and redevelopment projects
19. Develop prioritization strategy for performing watershed assessments
20. Research potential for including additional departments/disciplines in the development review process, such as stream determination, historic flooding, soil scientist, and environmental review standards
21. Research options for development BMPs to reduce urban heat island effect
22. Create a potential wetlands map
23. Maintain stormwater infrastructure mapping in coordination with neighboring jurisdictions
24. Expand the Environmental Stewardship Program (ESP)
25. Implement Firewise program in areas identified at risk.
26. Create incentives to correct water utilities for drought
27. Develop sinkhole mapping using LiDAR
28. Research options for requiring and enforcing the recommendations of the Hillside and Ridgetop Protection Plan.
29. Increase powerline maintenance to reduce instances of falling trees on powerlines and poles.
30. Research regulations and process to require storm saferoom construction in all new public buildings
31. Seek to identify and/or prioritize locations for community shelters for mobile home parks/manufactured housing. Secure funding for construction.
32. Continue roadway ditch maintenance to reduce roadway flooding, i.e. Concord Park on Northshore Drive.
33. Prioritize and secure funding for buyout of repetitive flood properties
34. Secure funding for protection and/or relocation of flood-prone critical facilities

35. Develop pro-active stormwater and/or public works maintenance program for stormwater infrastructure, including preventative culvert inspections and repair
36. Research options to increase funding for home weatherization, with priority of vulnerable population through the Weatherization Assistance Program and the Knoxville-Knox County Community Action Committee.
37. Maintain up-to-date building codes with transition to 2018 ICC Code Suite
38. Research potential to provide incentives for development outside of environmentally sensitive areas
39. Become Tree City certified and enhance urban tree cover to improve stormwater management and reduce urban heat island effect
40. Secure funding for roadway improvement projects that protect roadways from repetitive flooding
41. First Creek Improvements – 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.

Prioritization of Mitigation Actions

To prioritize the mitigation actions, ***each participating HMPC member is asked to evaluate the actions using a simple cost/benefit analysis*** (Table 1). Presented as a web-based survey, HMPC members will rate each mitigation action for both benefit (low, medium, or high) and funding impact (easy, potential, or difficult). A weighted score will then applied to the total number of votes within each cost/benefit category for a total priority score.

Table 1 Benefit/Cost Analysis

Benefit	**Definition**	**Weighted Value**
Low	Difficult to assess benefits of this action; long-term time-frame for implementation	1
Medium	Long-term impact on reduction of losses is anticipated; implementation within 5 years	2
High	Meaningful impact on reduction of losses; implementation within 5 years is important	3
Cost	**Definition**	**Weighted Value**
Difficult to Fund	Funding sources not secured; grant funding will be needed	1
Potential to Fund	Funding requires budgeting over multiple years; grant funding potential	2
Easily Funded	Funds to implement action are available in existing budget	3

The web-based survey is available here:

https://www.surveymonkey.com/r/KnoxCoMitigationActions

Figure 2 . Image of Web-based Survey

Knox County, City of Knoxville, and Town of Farragut - Hazard Mitigation Actions

Prioritization of Mitigation Actions

At the last mitigation planning meeting, multiple NEW mitigation actions were identified to reduce the impacts of the natural hazards identified in our risk assessment. The next step is to prioritize the mitigation actions for implementation. We ask for your input to prioritize the mitigation actions using a benefit/cost analysis. Please rank each mitigation action based upon BOTH benefit (low/med/high) and funding impact (low/med/high).

1. Amplify outreach/public education to encourage participation in Reverse 911 system.

- ☐ **LOW BENEFIT**: Difficult to assess benefits of this action; long-term time-frame for implementation
- ☐ **MEDIUM BENEFIT**: Long-term impact on reduction of losses is anticipated; implementation within 5 years
- ☐ **HIGH BENEFIT**: Meaningful impact on reduction of losses; implementation within 5 years is important
- ☐ **LOW COST**: Easily Fundedl Funds to implement action are available in existing budget
- ☐ **MEDIUM COST**: Potential to Fund; Funding requires budgeting over multiple years; grant funding potential
- ☐ **HIGH COST**: Difficult to Fund; Funding sources not secured; grant funding will be needed

2. Create and/or update existing KEMA fact sheets for natural hazards to define hazard risks and suggest personal mitigation actions.

- ☐ **LOW BENEFIT**: Difficult to assess benefits of this action; long-term time-frame for implementation
- ☐ **MEDIUM BENEFIT**: Long-term impact on reduction of losses is anticipated; implementation within 5 years
- ☐ **HIGH BENEFIT**: Meaningful impact on reduction of losses; implementation within 5 years is important
- ☐ **LOW COST**: Easily Fundedl Funds to implement action are available in existing budget
- ☐ **MEDIUM COST**: Potential to Fund; Funding requires budgeting over multiple years; grant funding potential
- ☐ **HIGH COST**: Difficult to Fund; Funding sources not secured; grant funding will be needed

3. Provide educational workshop and/or informational materials for the real estate industry including buyers, agents, and lenders.

- ☐ **LOW BENEFIT**: Difficult to assess benefits of this action; long-term
- ☐ **LOW COST**: Easily Fundedl Funds to implement action are available in

Next Steps

For HMPC Members/Attendees

- HMPC will complete the Mitigation Action Survey for prioritization of mitigation actions by **Friday, November 17th**
- HMPC will review and provide comments on Chapter 3 by **Friday, November 17th**
-

For Amec Foster Wheeler:

- Complete Chapters 1, 2, 4, and 5 for review. Once documents are placed on the DropBox site an email will be sent to all HMPC members.
- Incorporate final comments from the HMPC on mitigation actions and the plan document.
- Once incorporated, a full plan document will be provided for posting to the community websites for review and comment by the public.
- With final comments from the public incorporated, a full plan document will be submitted to TEMA for review prior to submittal to FEMA.

Attachment A – Powerpoint Presentation

Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan
UPDATE
Local Hazard Mitigation Plan
Mitigation Action Meeting
October 25, 2017

Cindy Popplewell
Amec Foster Wheeler
Environment & Infrastructure, Inc.

Agenda

1. Review
   - ✓ Planning process and progress
2. Hazard Identification and Risk Assessment (HIRA)
   - ✓ Updates from previous meeting
3. Mitigation Strategy
   - ✓ Possible Mitigation Activities and Alternatives
   - ✓ Key Issues for each hazard
   - ✓ Mitigation Action Prioritization and Implementation Plan
4. Next Steps of Planning Process
   - ✓ Prioritization of Mitigation Actions - Online
   - ✓ Review of Chapter 3
   - ✓ Distribution of Draft Report for Review
   - ✓ Public Input/Review Comment Period

Introductions

- Name
- Organization

10-Step Planning Process

ORGANIZE RESOURCES

1. Get Organized
2. Plan for Public Involvement
3. Coordinate with Other Departments and Agencies

ASSESS HAZARDS AND RISK

4. Identify Hazards
5. Assess the Risks

DEVELOP MITIGATION PLAN

6. Set Planning Goals
7. Review Possible Activities
8. Draft an Action Plan

IMPLEMENT THE PLAN

9. Adopt the Plan
10. Implement the Plan, Evaluate Work, Revise as Needed

10-Step Planning Process

ORGANIZE RESOURCES

1. Get Organized
2. Plan for Public Involvement
3. Coordinate with Other Departments and Agencies

ASSESS HAZARDS AND RISK

4. Identify Hazards
5. Assess the Risks

DEVELOP MITIGATION PLAN

6. Set Planning Goals
7. Review Possible Activities
8. Draft an Action Plan

IMPLEMENT THE PLAN

9. Adopt the Plan
10. Implement the Plan, Evaluate Work, Revise as Needed

10-Step Planning Process

ORGANIZE RESOURCES

1. Get Organized
2. Plan for Public Involvement
3. Coordinate with Other Departments and Agencies

ASSESS HAZARDS AND RISK

4. Identify Hazards
5. Assess the Risks

DEVELOP MITIGATION PLAN

6. Set Planning Goals
7. Review Possible Activities
8. Draft an Action Plan

IMPLEMENT THE PLAN

9. Adopt the Plan
10. Implement the Plan, Evaluate Work, Revise as Needed

Hazard Profiles

- Likelihood of future occurrence
  - **Highly Likely (4):** Near 100% probability in next year.
  - **Likely (3):** Between 10 and 100% probability in next year or at least one chance in ten years.
  - **Occasional (2):** Between 1 and 10% probability in next year or at least one chance in next 100 years.
  - **Unlikely (1):** Less than 1% probability in next 100 years.
- Magnitude/Severity
  - **Catastrophic (4):** Multiple deaths, complete shutdown of facilities for 30 or more days, more than 50 percent of property is severely damaged
  - **Critical (3):** 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.
  - **Limited (2):** 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.
  - **Negligible (1):** 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
  - **Extensive (3):** 50-100% of planning area
  - **Significant (2):** 10-50% of planning area
  - **Limited (1):** Less than 10% of planning area

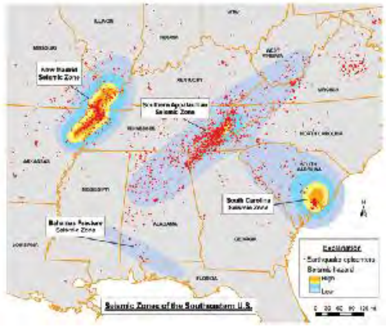
4. Identify the Hazards

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

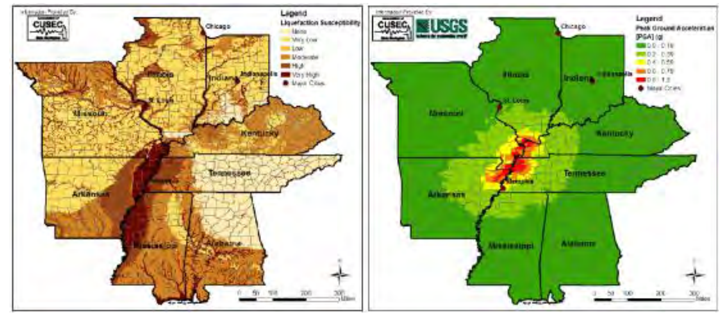
Hazard	Probability	Magnitude	Spatial Extent	Planning Significance	Ranking
Flood	4	2	3	3.1	High
Extreme Temperatures	4	2	3	3.1	High
Severe Storms	4	2	3	3.1	High
Land subsidence and sinkholes	4	2	2	2.9	Medium
Winter Storms	4	1	3	2.75	Medium
Landslides	3	2	2	2.45	Medium
Wildfires	4	1	1	2.35	Medium
Earthquake	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

Earthquake

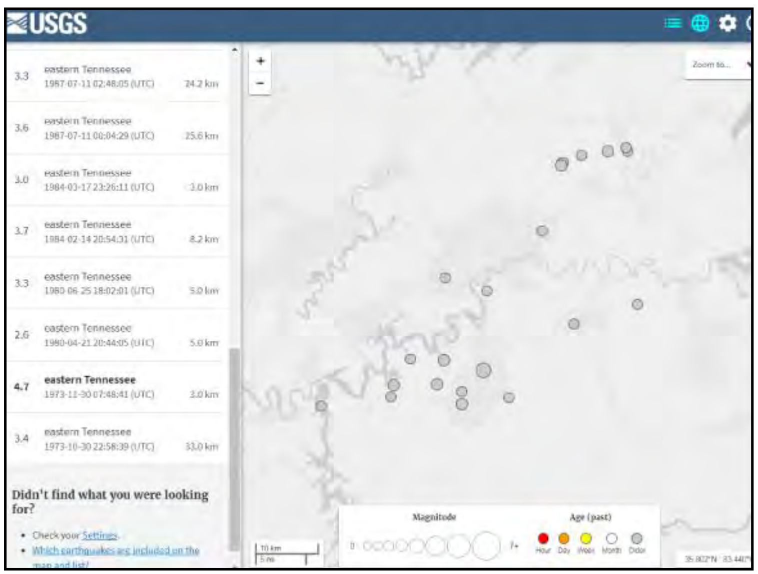
- East Tennessee Seismic Zone within the Southern Appalachian Seismic Zone



Earthquake



Ground Motion Maps for magnitude 7.7 earthquake



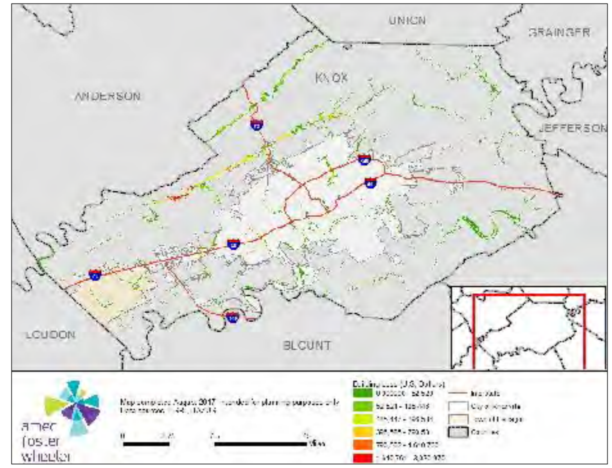
Earthquake

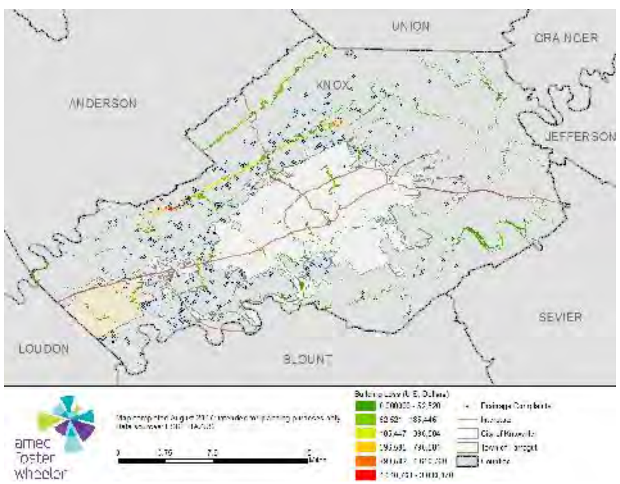
- ✓ Spatial Extent: Extensive, 50-100% of planning area
- ✓ Previous Occurrences: Knox Area – Since 1973, recent earthquakes near Knox County 3 have not exceeded a 3.0 magnitude; No structural damage
- ✓ Probability: Occasional, 3 in 44yr period; 6.8% chance
- ✓ Magnitude/Severity: Negligible, Injuries 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

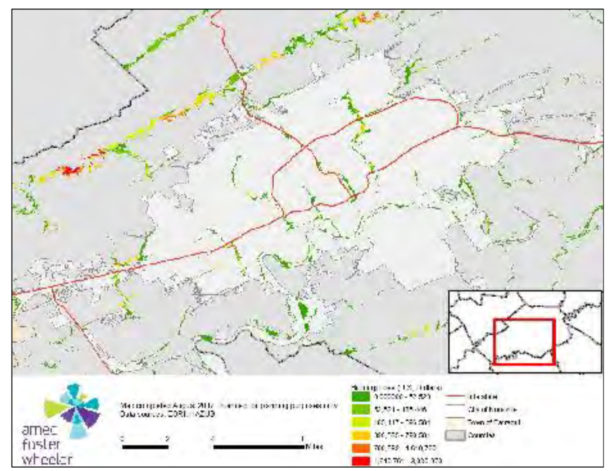
Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	2-Occasional	1-Negligible	3- Extensive	1.85 (Low)
Knox County (Unincorporated)	2-Occasional	1-Negligible	3- Extensive	1.85 (Low)
City of Knoxville	2-Occasional	1-Negligible	3- Extensive	1.85 (Low)
Town of Farragut	2-Occasional	1-Negligible	3- Extensive	1.85 (Low)

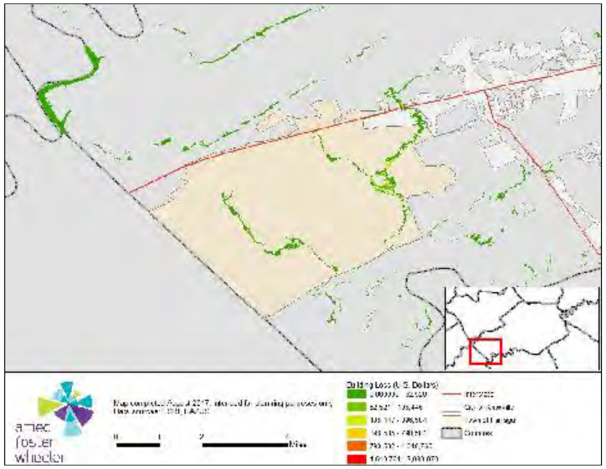
Flooding

Jurisdiction	# of Damaged Buildings	Building Damage ($)	Building Loss Ratio	Displaced Population
Knox County (unincorporated)	2,902	$32,656,279	2.49%	**6,735**
City of Knoxville	882	$13,083,584	1.48%	**1,944**
Town of Farragut	118	$803,803	0.77%	**213**
Total	**3,902**	**$46,543,667**	**2.02%**	**8,892**









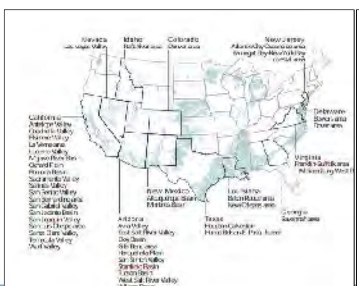
Wildfire

Year	# of Fires	Acres Burned
2006	6	21
2007	16	513
2008	7	119
2009	11	177
2010	6	10
2011	317	13
2012	386	244
2013	193	19
2014	410	161
2015	233	20
2016	419	35

- For 2011 – 2016 – There were 1,958 fires for a total loss of $17,350 with over 490 acres burned.

Land Subsidence/Sinkhole

- Updated definition to include:
  - Compaction of aquifer systems
  - Drainage and subsequent oxidation of organic soils
  - Dissolution and collapse of susceptible rocks - SINKHOLE



Mitigation Strategy

- Goals
- Actions

2017 Goals

General guidelines that explain what we want to achieve. They are long-term, broad, policy-type statements

- 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.
- Strengthen protection critical facilities and infrastructure from natural hazards to create a safer, more sustainable community.

Mitigation Actions

Specific Actions that help achieve our goals

- Losses from hazards can be reduced if communities take action before the next disaster
- Actions have long term and cumulative benefits
- Cumulative benefits should be greater than the cost.
- Some may be low-cost initiatives readily adopted
- Others may be dependent on available funding or best implemented following a disaster
- Relevant to your Jurisdiction
- Focus on Mitigation-not a Response Plan
- Not all actions identified through this planning process will be eligible for FEMA grants

Mitigation Actions

Specific Actions that help achieve our goals

- Prevention
- Property protection
- Natural resource protection
- Emergency services
- Structural projects
- Public information
- Multi-hazard measures and considerations

—See handouts (2)—

Pre-Brainstorming Session - Review Exisitng Actions

Existing Mitigation Actions

- Secure funding for a buyout of flood prone properties that experience repetitive flooding.
- Continue Participation in the National Flood Insurance Program (NFIP)*
- Secure funding for roadway improvement projects that would protect roadways from repetitive flooding.
- Secure funding for construction of regional detention basins.
- Secure funding for uninterruptible power supply battery-backup systems for traffic signals.
- Protect or relocate flood prone critical facilities.
- Provide Back-up power for critical facilities (water system pumps, hospitals, nursing homes, schools, etc.)

Existing Mitigation Actions

- First Creek Improvements – Walker Blvd.; Grainger; North of Tecoma
- Stormwater System Maintenance.
- Improve Rating within NFIP Community Rating System*
- 4th Creek – Northshore Bridge Improvements; 4th Creek Channel Stabilization
- Cherry Street Sinkhole Maintenance
- Construct tornado safe rooms in public buildings including schools.
- Increase powerline maintenance to reduce instances of falling trees on powerlines
- Roadway ditch maintenance to prevent roadway flooding

Brainstorming Session - New Actions

DMA Action Requirements

- Plan must have at least <u>one action for every hazard</u>
- Plan may include non-mitigation actions, such as actions that are emergency response or operational preparedness in nature. These will not be accepted as hazard mitigation actions, but neither will FEMA require these to be removed from the plan prior to approval.
- Actions must be prioritized
- Actions must have detail on implementation and administration
- Actions must address existing and future development

Brainstorming New Actions

- Review Handouts with Mitigation Actions by Categories and by Hazards
- What actions should be included in the Plan?
- Write your ideas down on 3 x 5 card
- Note the lead agency and any supporting agencies

Risk Assessment Highlights

Flooding

- 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.
  - 18 in unincorporated county, 36 in Knoxville, and one in Farragut.
- Flash-flooding occurs repeatedly in some areas – multiple drainage complaints outside of mapped floodplain
- Sinkhole flooding occurs within the planning area.
- 1,042 flood insurance policies in force with $291 million in coverage.
- $16,813 annualized losses to crops due to flooding and excessive moisture.
  - 83% of field crops are insured.
- 39 Critical Facilities in the Floodplain
  - 19 in unincorporated county; 20 in City of Knoxville; and 0 in Farragut.

Risk Assessment Highlights

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 – Public Meeting Input
- Power generation and transmission facilities can fail during periods of prolonged extreme heat.
- 16 long-term, nursing, and Medicare rehabilitation facilities in Knox County.
- Knoxville-Knox County Excessive Heat Plan, 2017

Jurisdiction	# Age 65 and Over	% Age 65 and Over	# Age Under 5	% Age Under 5	% Individuals Below Poverty Level
Knox County (unincorporated	33,714	13.5	8,902	3.6	Not available forthis geography
City of Knoxville	25,263	13.5	16,476	**5.9**	**25.7**
Town of Farragut	3,676	**17.2**	834	3.9	4.5
Total Knox County	62,653	14.1	26,216	5.9	16.0

Risk Assessment Highlights

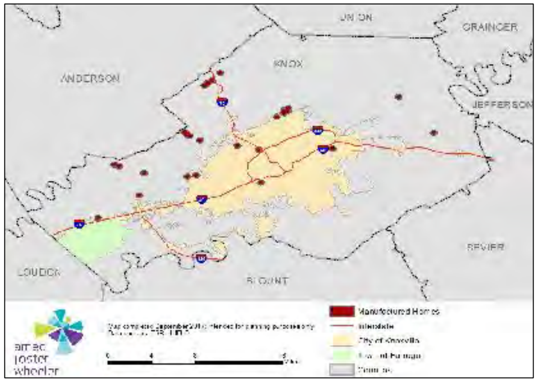
Severe Storms

- Manufactured homes, campers and light buildings at increased risk of damages.
- Nearly 9,299 manufactured homes in the planning area, most in unincorporated areas.
- Causes power outages from downed power lines.
- Annualized losses estimated at $120,000 based on NCDC historical accounts.

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.
- Sinkhole protection ordinance for the Town of Farragut

Risk Assessment Highlights



Risk Assessment Highlights

Winter Storms

- 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 $5.7 million in damages per day.

Landslides

- 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 2003 and 2009.
- Hillside and Ridgetop Protection Plan for City of Knoxville and Knox County.

Risk Assessment Highlights

Wildfire

- From 2011-2016 Knox County had 1,958 wildfires that burned 492 acres.
- Areas most vulnerable are agricultural areas where land is burned, rural areas where trash is burned, and wildland-urban interface areas.

Earthquakes

- Knox County experiences frequent low-magnitude events
  - 8 since 1973 exceeding 2.5; 3 since 1973 exceeding 3.0 (3.3, 3.6, 3.7)
- 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.

Risk Assessment Highlights

Tornado

- Almost 10,000 manufactured homes in the planning area, most are in unincorporated areas.
- Do mobile home parks have tornado saferooms for residents?
- 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.
- Total paid claims for crop insurance as a result of drought were $8,871 from 2007-2016.

Risk Assessment Highlights

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.

Suggested Mitigation Actions

- Continue to conduct multi-hazard public education program and outreach brochures
- Obtain dam inundation mapping for high hazard dams
- Conduct exercises for dam/levee failures based on Emergency Action Plan
- Coordinate Hazard Risk Assessments with other agencies, i.e. Health Department
- Develop countywide drought management plan
- Coordinate with Highway Department to identify and inspect critical bridge infrastructure
- Maximize opportunities to implement mitigation in the disaster recovery process utilizing hazard mitigation funding available under Section 406 (Public Assistance) of the Stafford Act

Brainstorming New Actions

- Review Handouts with Mitigation Actions by Categories and by Hazards
- What actions should be included in the Plan?
- Write your ideas down on 3 x 5 card
- Note the lead agency and any supporting agencies

Mitigation Actions

- Prioritization
- Implementation

Prioritization

Benefit	Definition	Weighted Value
Low	Difficult to assess benefits of this action; long-term time-frame for implementation	1
Medium	Long-term impact on reduction of losses is anticipated; implementation within 5 years	2
High	Meaningful impact on reduction of losses; implementation within 5 years is important	3
Cost	**Definition**	**Weighted Value**
Difficult to Fund	Funding sources not secured; grant funding will be needed	1
Potential to Fund	Funding requires budgeting over multiple years; grant funding potential	2
Easily Funded	Funds to implement action are available in existing budget	3

Prioritization - Example

Peoria County - Mitigation Actions

Prioritization of Mitigation Actions

1. Prepare "take-home" brochure for school system to address hazard preparedness planning and coordination.

2. Evaluate structural integrity of critical facilities and shelters to confirm resistance to hazard events.

Implementation Data and Example

- Responsible Office and Partners
- Potential Resources and/or Funding
- Estimated Cost Level
- Timeframe

Action ID	Mitigation Action	Responsible Office	Partners	Potential Resources/Funding	Estimated Cost Level	Timeframe
16	Organize public workshop to discuss flood mitigation and property protection.	• Planning & Zoning		Existing Budget/Manpower	Low to Medium	Within 12 months
17	[illegible]	• Planning & Zoning		Existing Budget/Manpower	Low	Within 12 months
18	Establish prioritized list for mitigation of flood prone structures.	• Planning & Zoning		Existing Budget/Manpower	Low	Within 12 months
19	Establish process for conversion of acquired flood properties to natural habitat.	• Planning & Zoning		Existing Budget/Manpower	High	Within 3 to 5 years
20	Post education signage in areas of acquired flood properties describing benefits of natural habitat.	• Planning & Zoning		Existing Budget; FEMA Hazard Mitigation Assistance (HMA) grant funding	Medium to High	Within 3 to 5 years
21	Update landscape ordinance to provide homeowner credit for use of native plantings.	• Planning & Zoning		Existing Budget/Manpower	Medium to High	Within 1 to 3 years
22	Continue acquisition program to mitigate repetitive flood properties.	• Planning & Zoning		Existing Budget; FEMA Hazard Mitigation Assistance (HMA) grant funding	High	Within 12 months
23	[illegible]	• Planning & Zoning		Existing Budget/Manpower	Low to Medium	Within 1 to 3 years

Next Steps of Planning Process

Next Steps

- Survey for Mitigation Action Prioritization
  - *By November 10th*
- Review Chapter 3 – DropBox Delivery end of Week
  - *By November 10th*
  - *Current Document*
- Review Draft Plan
  - *By Novemer 30th*
- Contact ANYTIME with questions or concerns

cindy.popplewell@amecfw.com
(615) 333-0630 ext. 7050
(303) 704-8939

farragut

Attachment B – Sign-In Sheets

amec foster wheeler

Sign-In Sheet- October 25, 2017

Name	Title	Department	Email	Phone
Bart Hose	planner	Town of Farragut	bhose@townoffarragut.org	966-7057
Amy Mann	NPDES PM	Knox Co. S/W	amy.mann@knoxcounty.org	865 215 5283
David Hagerman	Stormwater Manager	COK Engineering	dhagerman@KnoxvilleTN.gov	215-3251
Lori Saal	Stormwater Coord.	TOF engineering	lsaal@townoffarragut.org	966-7057
Colin Ickes	Director	Emergency Management	cickes@knoxvilletn.gov	215-1166
Erin Gill	Director	Sustainability	egill@knoxvilletn.gov	5-4430
Brian Woods	Captain	Rural Metro FD	brian-woods@ruralmetrofire.com	389-4492
L Hatfield	Lawyer	City of Knoxville	lhatfield@KnoxvilleTN.gov	
Carmy Olsen	COU	Knox County	colsen@knoxcounty.org	865 406 4348

amec foster wheeler

Sign-In Sheet- October 25, 2017

Name	Title	Department	Email	Phone
EDDY ROBERTS	KNOX COUNTY	STORMWATER	eddy.roberts@knoxcounty.org	865-215-5234
Eric Knoefel	Captain	RURAL METRO Fire	eric.knoefel@RURALMETROFIRE.COM	865-388-9459
DAVID SPARKS	ASST. ENGINEER	FARRAGUT ENGINEERING	DSPARKS@TOWNOFFARRAGUT.ORG	966-7057
DAN KELLY	Dep. D.R. MPC	MPC	dan.kelly@knoxmpc.org	215-3440
David McGinley	Stormwater Engineering Manager	COK	DMcGinley@KnoxvilleTN.Gov	215-2072
JOHN SEXTON	STAFF TRANS. ENGR	KNOX Co. EPW	john.sexton@knoxcounty.org	215-5860
Todd Napier	Dev. Corp Knox County		tanapier@knoxdevelopment.org	246-2650
DAVID HIXENBAUGH	~~david hixenbaugh~~ SAFETY	KUB	david.hixenbaugh@kub.org	865-558-2823
Chris Granju	Stormwater Div	Knox Co.	chris.granju@knoxcounty.org	865-215-5840

COMMUNITY MEETING

Sign-In Sheet- October 25, 2017

Name	Title	Department	Email	Phone
EDDY ROBERTS	KNOX COUNTY	ENGINEERING	eddy.roberts@knoxcounty.org	865-215-5234
David McGinley	COK	ENG	DMcGinley@knoxvilleTN.GOV	865-215-2072
Eshin Gill	COK	Sustainability	egill@knoxvilletn.gov	865-215-4430
[illegible]	/		[illegible]@gmail.com	865 441-7252
STAN Johnson	ED SEEED		s.johnson692@gmail.com	865-936-2623
Rick Held	SEEED DIRECTOR CMTY ENGAGEMENT	Community Engagement	rickyheldmail@gmail.com	865-936-4492
ron davis	Member NAACP		deva.assoc@gmail.com	865-719-1132
ANNA DAVIS			tinsy01@gmail.com	865-386-5062 (c)

Knoxville Tennessee Branch

NAACP

The following resolution was approved at the October 5, 2017 Knoxville Branch NAACP membership meeting:

Resolution: Knoxville Branch of the NAACP urges the Hazard Mitigation Plan committee to prioritize within the Hazard Mitigation Plan an emergency response to multiple days of excessive heat to protect vulnerable populations from life-threatening risks of excessive heat and to develop mitigation plans to weatherize housing of the most vulnerable.

- Among the vulnerable population most at risk from excessive heat are the elderly, invalid, homeless, infants, poor, and socially isolated.
- Multiple days of excessive heat create life threatening conditions among vulnerable populations. Summer temperatures have been rising over the past decade and are projected to continue to do so.
- Most mortalities caused by excessive heat are preventable through public education and activating a full emergency community response when threshold temperatures are forecast by opening cooling shelters, encouraging neighbors to check on vulnerable neighbors, and other similar responses.
- The accepted threshold weather conditions to activate a full emergency response is when multiple days are forecast with temperatures ten degrees above the average high for the month.
- Elements of an excessive heat emergency plan include:
  - an accurate and timely alert system;
  - strategies to reduce the exposure of vulnerable population to heat;
  - particular care for "vulnerable" populations.
- The Excessive Heat Plan prepared by KEMA is definitely in the right direction with its inclusion of cooling shelters. However, we do have concerns about it, two of which include the threshold activation temperature and emergency use of city and church facilities. Further, greater agency and public engagement is needed to further develop a community heat emergency response.

Beyond developing a community emergency response to heat waves, the Hazard Mitigation Plan needs to include mitigation plans to reduce the effects of excessive heat:

- Weatherization of residences of vulnerable populations.
- Applying medium-term and short-term options for passive cooling to reduce the effects of the urban heat island effect.

Resolution: Knoxville Branch of the NAACP urges the Hazard Mitigation Plan committee to:

- work with the leadership within the most vulnerable neighborhoods to develop the emergency response plan,
- develop mitigation plans to weatherize homes of the vulnerable populations,
- develop the emergency response and mitigation plans by the end of 2018, and
- provide for meaningful public engagement in the process of developing these plans.

Knoxville Tennessee Branch

NAACP

Community Support for
Knoxville Community Response to Heat-Waves

We urge the Knox-Knoxville Hazard Mitigation Plan to include an effective community response to heat-waves to protect our most vulnerable neighbors from the life-threatening risks of excessive heat.

Chelsea	Badgett	37902	cmbadgett77@gmail.com
Elijah	Bowman Jr	37909	elijahbowmanjr@gmail.com
Max	Carwile	37912	Knoxfeministaction@gmail.com
Louise	Gorenflo	37912	lgorenflo@gmail.com
Jean	Robinson	37914	jeanreif63@gmail.com
Joe	Franklin	37914	jgfranklin2010@gmail.com
Titus	Williams	37915	tituswilliams3@gmail\.com
Christopher	Battle	37915	Pastorcbattlesr@gmail.com
LaKenya	Middlebrook	37915	middlebrooklaw@gmail.com
David	Wasilko	37916	Dwasilko@vols.utk.edu
carol	nickle	37917	carolsnickle@att.net
Louise	Seamster	37917	theseamster@gmail.com
Pat	Garrison	37917	patgarrison0@gmail.com
Kenneth	Crockett	37917	once-ler@att.net
Gloria	Johnson	37917	glostik@bellsouth.net
Lou	Murrey	37917	lnmurrey@gmail.com
Rae	Jones	37917	emailraejones@gmail.com
Melanie	Barron	37917	melbtennessee@gmail.com
Courtney	Shea	37918	courtshea@aol.com
Sherrie	Raymond	37918	sgraymond@outlook.com
Steve	Rodgers	37918	metricmodulation@gmail.com
Emma	Takvoryan	37918	rozyln@hotmail.com
Deb	Patterson	37918	geomantra@gmail.com
Marta	Murrell	37919	marta.murrell@gmail.com

Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan Update

Knox County, the City of Knoxville, and Town of Farragut are beginning the process to update the Multi-Jurisdictional Local Hazard Mitigation Plan to better protect the people and property of the communities from the effects of natural hazard events and to obtain eligibility for mitigation funding from the Federal Emergency Management Agency (FEMA).

Phase I	1.	Organize Planning Team
	2.	Plan for Public Involvement
	3.	Coordinate with Other Departments/Agencies
Phase 2	4.	Identify the Hazards
	5.	Estimate Losses
Phase 3	6	Identify Goals and Objectives
	7.	Develop Potential Mitigation Actions
	8.	Draft the Mitigation Plan
Phase 4	9.	Adopt the Plan
	10.	Implement and Maintain the Plan

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 and earthquakes to tornadoes, and severe winter weather. The plan will assess the likely impacts of these hazards to the unincorporated areas of Knox County, the City of Knoxville, and the Town of Farragut. 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?

- The planning team would like your input on a public survey. This survey captures public opinion on the hazards that are the most significant to you as well as the types of activities that you think will help prevent or reduce losses: **www.surveymonkey.com/r/Knox_Mitigation**
- Additionally, an Public Meeting will be held on September 26th to get kickoff the planning process with the public and stakeholders:
  5:00 – 7:00pm Tuesday, September 26, 2017
  Public Works Service Center, Large Conference Room
  3131 Morris Ave, Knoxville, TN 37909

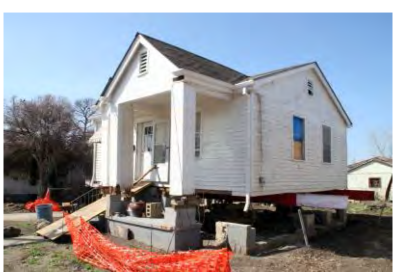


Photo Source: FEMA

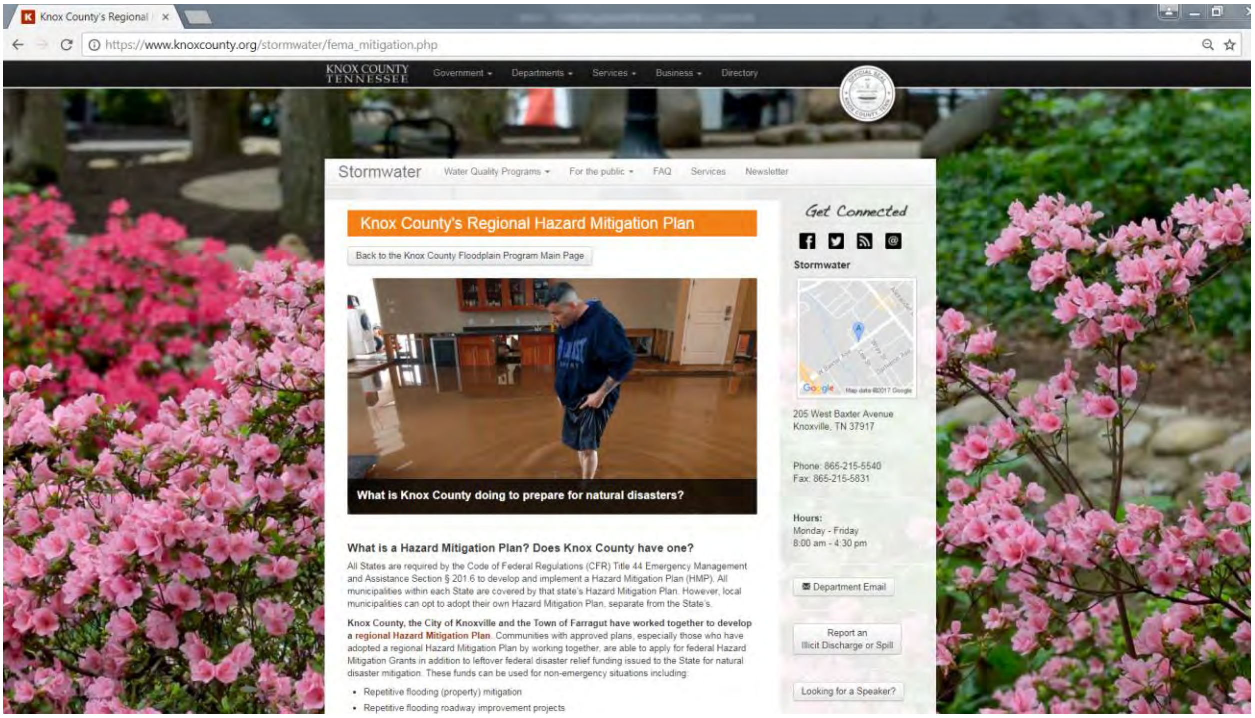
Planning Status

The planning team is currently working within Phase 1: Organize Resources. On July 11, 2017, the planning team held a kick-off meeting to organize the planning effort, plan for public involvement opportunities and initiate coordination with other departments and agencies.

Implementation of the Plan is the Ultimate Goal!

The ultimate goal of this planning process is implementation of mitigation actions that will prevent or lessen the impacts of hazards to people and property in your community. An example is the elevation of structures that repeatedly flood, reducing structural damage in the event of future flooding.

For more information please contact Eddy Roberts at (865) 215-5234 or Eddy.Roberts@knoxcounty.org



Knox County's Regional

https://www.knoxcounty.org/stormwater/fema_mitigation.php

KNOX COUNTY TENNESSEE | Government | Departments | Services | Business | Directory

Stormwater | Water Quality Programs | For the public | FAQ | Services | Newsletter

Knox County's Regional Hazard Mitigation Plan

Back to the Knox County Floodplain Program Main Page

What is Knox County doing to prepare for natural disasters?

What is a Hazard Mitigation Plan? Does Knox County have one?

All States are required by the Code of Federal Regulations (CFR) Title 44 Emergency Management and Assistance Section § 201.6 to develop and implement a Hazard Mitigation Plan (HMP). All municipalities within each State are covered by that state's Hazard Mitigation Plan. However, local municipalities can opt to adopt their own Hazard Mitigation Plan, separate from the State's.

Knox County, the City of Knoxville and the Town of Farragut have worked together to develop a regional Hazard Mitigation Plan. Communities with approved plans, especially those who have adopted a regional Hazard Mitigation Plan by working together, are able to apply for federal Hazard Mitigation Grants in addition to leftover federal disaster relief funding issued to the State for natural disaster mitigation. These funds can be used for non-emergency situations including:

- Repetitive flooding (property) mitigation
- Repetitive flooding roadway improvement projects

Get Connected

Stormwater

205 West Baxter Avenue
Knoxville, TN 37917

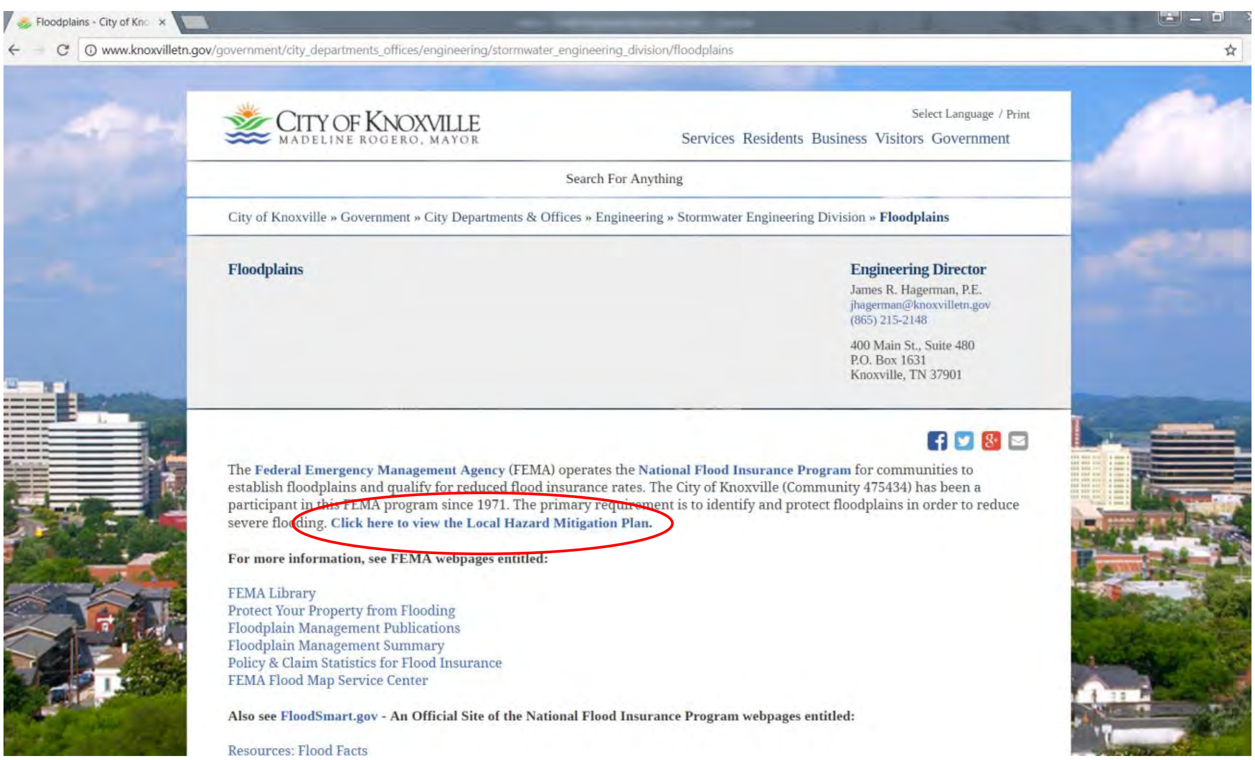
Phone: 865-215-5540
Fax: 865-215-5831

Hours:
Monday - Friday
8:00 am - 4:30 pm

Department Email

Report an Illicit Discharge or Spill

Looking for a Speaker?



Floodplains - City of Knc

www.knoxvilletn.gov/government/city_departments_offices/engineering/stormwater_engineering_division/floodplains

CITY OF KNOXVILLE
MADELINE ROGERO, MAYOR

Select Language / Print

Services Residents Business Visitors Government

Search For Anything

City of Knoxville » Government » City Departments & Offices » Engineering » Stormwater Engineering Division » **Floodplains**

Floodplains

Engineering Director
James R. Hagerman, P.E.
jhagerman@knoxvilletn.gov
(865) 215-2148

400 Main St., Suite 480
P.O. Box 1631
Knoxville, TN 37901

The Federal Emergency Management Agency (FEMA) operates the National Flood Insurance Program for communities to establish floodplains and qualify for reduced flood insurance rates. The City of Knoxville (Community 475434) has been a participant in this FEMA program since 1971. The primary requirement is to identify and protect floodplains in order to reduce severe flooding. **Click here to view the Local Hazard Mitigation Plan.**

For more information, see FEMA webpages entitled:

FEMA Library
Protect Your Property from Flooding
Floodplain Management Publications
Floodplain Management Summary
Policy & Claim Statistics for Flood Insurance
FEMA Flood Map Service Center

Also see FloodSmart.gov - An Official Site of the National Flood Insurance Program webpages entitled:

Resources: Flood Facts

Natural Hazard Mitigatio

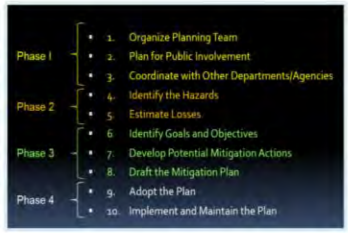
www.townoffarragut.org/documentcenter/view/3769

Natural Hazard Mitigation is sustained action taken to reduce or eliminate long-term risk to human life and p... 1 / 1

Town of Farragut, Knox County, and the City of Knoxville Multi-Jurisdictional Local Hazard Mitigation Plan Update

The Town of Farragut, in collaboration with Knox County and City of Knoxville, is beginning the process of updating the Multi-Jurisdictional Local Hazard Mitigation Plan to better protect the people and property of the communities from the effects of natural hazard events and to obtain eligibility for mitigation funding from the Federal Emergency Management Agency.

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 and earthquakes to tornadoes, and severe winter weather. The plan will assess the likely impacts of these hazards to the unincorporated areas of Knox County, the City of Knoxville, and the Town of Farragut. 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?

- The planning team would like your input on a public survey. This survey captures public opinion on the hazards that are the most significant to you as well as the types of activities that you think will help prevent or reduce losses: www.surveymonkey.com/r/Knox_Mitigation
- Additionally, a public meeting will be held to kickoff the planning process involving the public and stakeholders: **5:00 – 7:00 p.m. Tuesday, September 26, 2017**
  City of Knoxville Public Works Service Center, Large Conference Room

Knox County, City of Knoxville, and Town of Farragut
Multi-Jurisdictional Local Hazard Mitigation Plan
UPDATE
Public Meeting
September 26, 2017

Cindy Popplewell
Amec Foster Wheeler
Environment & Infrastructure, Inc.

What Is Mitigation?

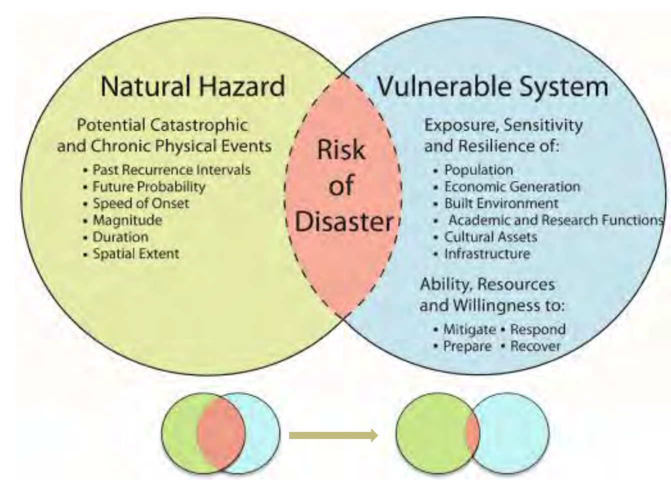
<u>Sustained action</u> taken to reduce or eliminate <u>long-term risk</u> to human life and property from natural and manmade hazards.

- Prevention
- Property Protection
- Public Education and Awareness
- Natural Resource Protection
- Emergency Services
- Structural Projects

What Is Mitigation Planning?

A <u>process</u> for communities to:

- Identify the natural and/or manmade hazards to which we are at risk;
- Assess the potential impacts of those hazards;
- Develop goals, objectives, and actions to reduce impacts; and
- Prioritize and implement mitigation actions.



Why Mitigation Planning?

- Increasing Cost of Disaster Response and Recovery
  - Cost of "Doing Nothing" Too Much
- Population Growth and Development
  - More People, Buildings, Infrastructure in Hazardous Areas
    - Knox County: 2010 - 432,226; 2016 - 456,132 5.5%
    - Knoxville: 2010 – 178,874; 2016 - 186,239 4.4%
    - Farragut: 2010 – 20,676; 2016 - 22,282 7.6%
- More Disaster Declarations (1953-2016)
  - Average 59 Declarations/year
  - 1990-1999 – 74/year; 2000-2010 – 124/year
  - Severe storms, flooding, hurricanes, and tornadoes
  - Billions of Tax Dollars Spent

Most Expensive Presidential Disaster Declarations

Event	Year	FEMA Funding
Hurricane Katrina (FL,LA,MS,AL)	2005	$38,318,576,948
Hurricane Sandy (NY, NJ, MD)	2012	$12,627,000,000
Attack on America - WTC (NY, NJ, VA)	2001	$8,818,350,120
Northridge Earthquake (CA)	1994	$6,978,325,877
Hurricane Rita (TX,LA)	2005	$3,749,698,351
Hurricane Ivan (LA,AL,MS,FL,NC,GA,NJ,PA,WV,NY,TN)	2004	$2,431,034,355
Hurricane Georges (AL, FL, MS, PR, VI)	1998	$2,245,157,178
Hurricane Wilma (FL)	2005	$2,110,738,364
Hurricane Charley (FL,SC)	2004	$1,885,466,628
Hurricane Andrew (FL,LA)	1992	$1,813,594,813
Hurricane Frances (FL,NC,PA,OH,NY,GA,SC)	2004	$1,773,440,505

Recent Disaster Declarations in Tennessee

Date	Disaster Type
06/23/2017	Severe Storms, Straight-Line Winds, and Flooding
12/15/2016	Wildfires
04/02/2015	Severe Winter Storm and Flooding
08/13/2014	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding
04/11/2014	Severe Winter Storm
03/16/2012	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding
07/20/2011	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding
05/09/2011	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding
05/04/2011	Flooding
05/01/2011	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding
03/31/2011	Severe Storms, Tornadoes, and Flooding
09/15/2010	Severe Storms and Flooding
05/04/2010	Severe Storms, Tornadoes, Straight-Line Winds, and Flooding

Why Mitigation Planning?

- Many Events are Predictable and Repetitive
- Loss Reduction Activities Work!
  - A dollar spent on mitigation saves society an average of $4.00
  - Mitigation is sufficiently cost-effective to warrant federal funding on an ongoing basis both before disasters and during post-disaster recovery
  - 10 Years since Mitigation Saves, increased focus on promoting:
    - Sustainability
    - Resilience
    - Safe Growth

Why Mitigation Planning?

- Disaster Mitigation Act of 2000
- Public Law 106-390; Amendment to the Stafford Act

Requires local governments to adopt a natural hazard mitigation plan to maintain eligibility for FEMA mitigation funds:

- Hazard Mitigation Grant Program (HMGP)
- Pre-Disaster Mitigation (PDM) Program
- Flood Mitigation Assistance (FMA) Program

farragut

Requirements of Mitigation Planning

10-Step Planning Process

ORGANIZE RESOURCES

1. Get Organized
2. Plan for Public Involvement
3. Coordinate with Other Departments and Agencies

ASSESS HAZARDS AND RISK

4. Identify Hazards
5. Assess the Risks

DEVELOP MITIGATION PLAN

6. Reaffirm/Update Planning Goals
7. Review Possible Activities
8. Draft an Action Plan

IMPLEMENT THE PLAN

9. Adopt the Plan
10. Implement the Plan, Evaluate Work, Revise as Needed

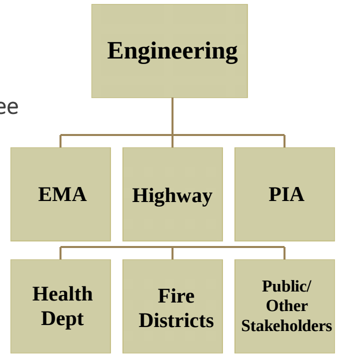
farragut

Summary of Plan Elements

farragut

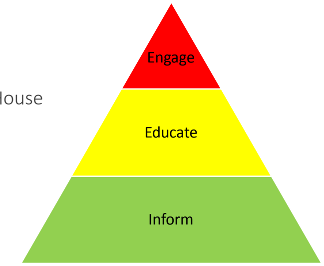
1. Get Organized

- Determine the Planning Area and Build the Planning Team
- Hazard Mitigation Planning Committee
  - Committee Members – core group responsible for making decisions, driving the planning process, and agreeing upon the final contents of the plan
  - Public/Other Stakeholders – individuals or groups that affect or can be affected by a mitigation action or policy



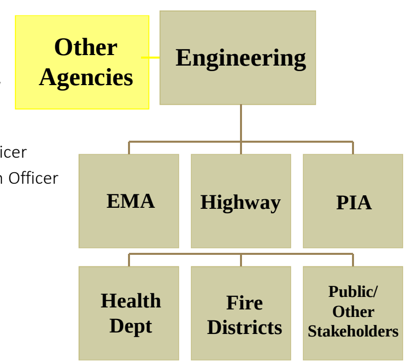
2. Plan for Public Involvement

- ENGAGE
  - Include on HMPC
- EDUCATE
  - Host Public Input Meetings/Open House
  - September 26 and October 25
- INFORM
  - Post Data on Websites
  - Informational Flyers
  - On-line Questionnaire
    - **www.surveymonkey.com/r/Knox_Mitigation**
  - Opportunity to review draft document



3. Coordinate with Other Departments and Agencies

- Invite to HMPC Meetings
- Request hazard data
- Send Draft Report for Review
- Identified Agencies include:
  - TEMA State Hazard Mitigation Officer
  - FEMA Region IV Hazard Mitigation Officer
  - State NFIP Coordinator
  - US Army Corps of Engineers
  - TVA
  - NRCS
  - NOAA / National Weather Service
  - Neighboring Communities



4. Identify the Hazards

- Identify all the possible hazards affecting the planning area.
- Profile the hazards
  - Hazard Description
  - Spatial Extent
  - Past Occurrences
  - Magnitude/Severity
  - Frequency/Likelihood of future occurrences
  - Changing Future Conditions
  - Define Planning Significance

Natural	
Dam Failure	Land Subsidence/ Sinkholes
Drought	Landslide
Earthquake	Severe Thunderstorms
Expansive Soils	Tornado
Extreme Temperatures	Wildfire
Flood	Winter Storms

Hazard Identification and Risk Assessment

1. Hazard Identification
   - ✓ Tennessee State Hazard Mitigation Plan
   - ✓ Previous Disaster Declarations
   - ✓ Previous Multi-Jurisdictional Local Hazard Mitigation Plan
2. Hazard Profiles
   - ✓ Description
   - ✓ Geographic Location
   - ✓ Previous Occurrences
   - ✓ Probability of Future Occurrences
   - ✓ Magnitude/Severity
   - ✓ Changing Future Conditions
3. Vulnerability Assessment
   - ✓ Inventory Assets
   - ✓ Estimate Losses ($)

farragut

4. Identify the Hazards (2017)

Hazard	Probability	Magnitude	Spatial Extent	Planning Significance	Ranking
Flood	4	2	3	3.1	High
Extreme Temperatures	4	2	3	3.1	High
Severe Storms	4	2	3	3.1	High
Winter Storms	4	1	3	2.75	Medium
Land subsidence and sinkholes	3	2	2	2.45	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	2	2.0	Medium
Dam Failure	1	2	2	1.55	Low
Expansive soils	1	1	1	1	Low

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

farragut

5. Assess the Risk

- ➢ Inventory residential & commercial structures
- ➢ Inventory critical facilities
- ➢ Determine # and value of structures
- ➢ Determine # of people in area
- ➢ Identify vulnerable infrastructure
- ➢ Identify development trends and constraints
- ➢ Identify cultural, natural and historic resource areas
- ➢ Estimate the losses

farragut

5. Assess the Risk

Methodologies:

- ➢ Geographic Analysis
- ➢ Historical / Statistical Analysis
- ➢ Data Presentation / Scenario Analysis

farragut

Geographic Analysis

Used for hazards with geographic risk areas

- Earthquake
- Land Subsidence/Sinkholes
- Landslide
- Riverine Flooding
- Wildfire

Identifies existing and future assets located in identified hazard areas

GIS Data Sets

- Risk Areas
- Assets – parcel data from Knox County

Historical/Statistical Analysis

Used for hazards that occur often with a repository of historical data

- Drought
- Extreme Heat/Cold
- Severe Storm – High Wind/Lightning/Hail
- Tornado
- Winter Storm

Employs Statistical Analysis of previous events and impacts/costs to determine potential future impacts/costs

Qualitative Analysis

Qualitative Analysis or Data Presentation is used for hazards that either do not have much history of occurrence or cascading impacts from other hazards

- Dam Failure
- Expansive Soils

Risk Assessment Methodology

	Vulnerability and Loss Estimation Method
Dam Failure	• 2011 - Qualitative Analysis • 2017 - Need inundation mapping for full loss estimation
Drought	• 2011 – Historical/Statistical Analysis - Loss of Water Estimate ($93 per person per day) – population based • 2017 – Add crop loss estimations
Earthquake	• 2011 - HAZUS-MH Loss Estimation • 2017 – Add critical facilities; Add bridge data, as available
Extreme Temperature	• 2011 – Historical/Statistical Analysis - Population statistics • 2017 – Add crop loss estimations
Expansive Soils	• 2011 – Qualitative Analysis • 2017 – Update qualitative analysis
Flood	• 2011 - HAZUS-MH Loss Estimation • 2017 - Incorporation of FIRM and/or Risk MAP Data, as available

Risk Assessment Methodology

	Vulnerability and Loss Estimation Method
Land Subsidence	• 2011 - GIS-based risk modeling; bldg. counts and values over known sinkholes • 2017 - GIS-based risk modeling; bldg. counts and values over known karst areas
Landslide	• 2011 - Qualitative analysis • 2017 - GIS-based risk modeling; Areas of high susceptibility and high incidence, as available
Severe Storms	• 2011 – Historical/Statistical Analysis - Loss of power; Annualized property loss • 2017 – Loss of power; Updated annualized property loss
Tornadoes	• 2011 - Historical/Statistical Analysis based on housing density • 2017 – Updated Statistical Analysis based on housing density
Wildfire	• 2011 - Historical/Statistical Analysis based on previous occurrences, annualized loses • 2017 – GIS Based analysis using Wildfire Urban Interface and Intermix areas, as available
Winter Storm	• 2011 – Historical/Statistical Analysis - Loss of power; Annualized property loss • 2017 – Loss of power; Updated annualized property loss

5. Assess the Risk

Capability Assessment – How prepared are we now?

- Regulatory
- Administrative/Technical
- Fiscal
  - Plans, studies, ordinances, etc.
  - Codes, regulations
  - Ability to implement hazard mitigation projects
  - Gap analysis
  - Review of possible activities

Regulatory Tool (ordinances, codes, plans)	Y/N	Comments
General plan		
Zoning ordinance		
Subdivision ordinance		
Growth management ordinance		
Floodplain ordinance		
Other special purpose ordinance (stormwater, steep slope, wildfire)		
Building code		Version:
BCEGS Rating		
Fire department ISO rating		Rating:
Erosion or sediment control program		
Stormwater management program		
Site plan review requirements		
Capital improvements plan		
Economic development plan		
Local emergency operations plan		
Other special plans		
Flood insurance study or other engineering study for streams		
Elevation certificates		
Other		

6-9. Develop the Mitigation Plan

- Review existing goals and objectives – update as needed
- Review existing mitigation actions – update progress
- Identify new mitigation actions to reduce vulnerability with emphasis on new and existing buildings and infrastructure
  - Who is going to do it? Responsible Department
  - When is it going to be completed? Setting timeline
  - How is it going to be financed? Potential funding sources
- Adopt the Plan

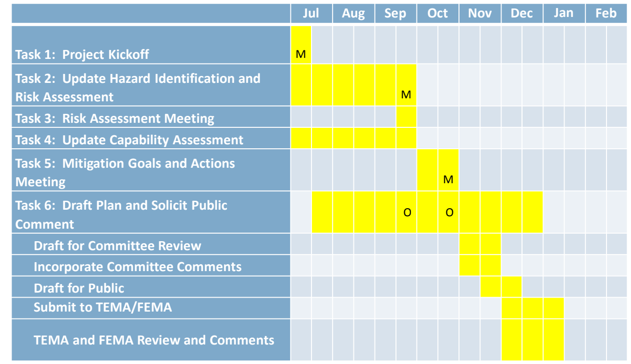
10. Implement, Evaluate, and Revise

- Plan must be updated every 5 years
- Should evaluate progress for implementation every year or more often
- Identify process to incorporate plan into other plans and programs
- Describe methods to maintain public involvement – reporting on progress and publicizing successes

Timeline of Planning Process

Timeline for Planning Process

✓Set Dates for Upcoming Meetings



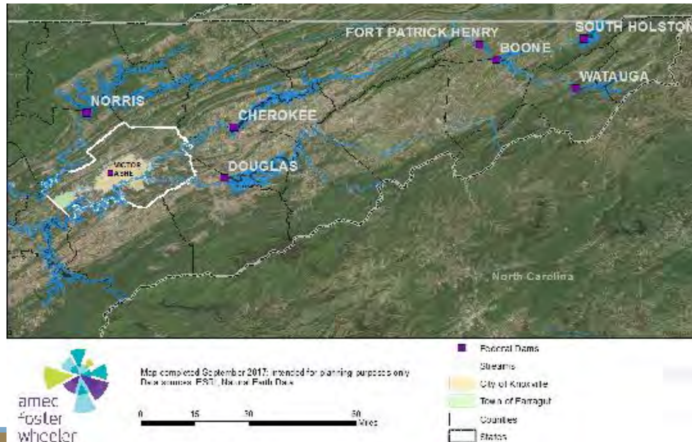
Questions?

Dam Failure

- Regulated dams in Knox County
  - 1, Victor Ashe, tributary of Third Creek
  - Low hazard, max storage 25 acre-feet
- Upstream of Planning Area
  - 7 federally regulated dams - TVA

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

Dam Failure



Dam Failure

- **Spatial Extent:** Significant - 10-50% of planning area
- **Previous Occurrences:** No dam failures reported
- **Probability:** Because dam failure is generally a secondary effect of other causes and hazards, calculating probability is difficult.
  - Unlikely - Less than 1% probability in next 100 years.
- **Magnitude/Severity:** 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.

Probability	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)

Dam Failure

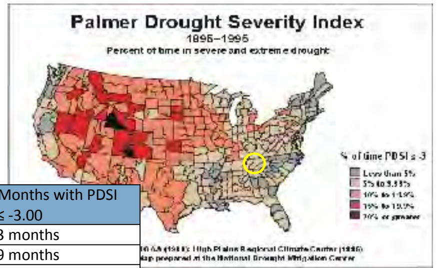
2017 Plan Update

- No significant changes to hazard profile
- Changing Future Conditions
  - With heavy reliance on other causes like design error, inadequate maintenance and upkeep, changing future conditions are not directly related to dam failure.
  - However, increased rainfall and flooding events are predicted to occur in the future which could potentially put a stress on dams and increase the likelihood of dam failure.
- Include mitigation action to address preparedness, such as training exercises and emergency action plans

Drought

- A period of excessive dryness long or intense enough to result in water-related problems.
- Slow moving hazard which causes losses to agriculture; contributes to wildfire; and affects domestic water supply, energy production, public health, and wildlife.
- Agricultural Areas
  - Existing Land Use - agriculture/Forestry/vacant land 152,633 acres; 46.9% of County land
  - KGIS Parcel Database - Land Use as Agriculture 116,603 acres; 35.8% of County land
  - 2012 Ag Census – 65,347 acres farm land; 20.1% of County land area

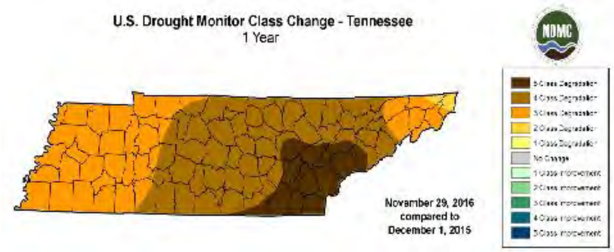
Drought



Year	Number of Months with PDSI ≤ -3.00
2013	3 months
2012	9 months
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

During 67- year period (804 months), eastern Tennessee was in severe to extreme drought for 65 months. This equates to 8.1 percent of the time.

Drought



Drought

- Spatial Extent: Significant - 10-50% of planning area
- Previous Occurrences:
  - 1952 – 1955; 1981; 1986 – 1988; 2007 – 2008; 2012 - 2013
- Probability: Occasional - Between 1 and 10% probability in next year or at least one chance in next 100 years.
- Magnitude/Severity: 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.

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	2-Occaisonal	2-Limited	2-Significant	2.0 (Medium)
Knox County (Unincorporated)	2-Occaisonal	2-Limited	2-Significant	2.0 (Medium)
City of Knoxville	2-Occaisonal	2-Limited	2-Significant	2.0 (Medium)
Town of Farragut	2-Occaisonal	2-Limited	2-Significant	2.0 (Medium)

Drought

2017 Plan Update

- Update previous occurrences and agricultural area
- Update spatial extent; raise significance to medium
- Changing Future Conditions
  - Typical characteristics of drought across the U.S. are altering due to a changing climate according to NOAA. A changing future climate is more likely to result in droughts being drier than expected because warmer temperatures increasing evaporation. Changing climate predications also show drought intensity and risk increasing.
- Continue to monitor water and climate data to better understand local climate and drought history; monitor water supply; development of drought emergency plan; conservation; TN State Drought Management Plan

Risk Assessment

- Drought

Jurisdiction	2016 Population Estimate	Loss of Water Estimate ($93 per person per day)
Knox County (Unincorporated)	247,611	$ 23,027,823
City of Knoxville	186,239	$ 17,320,227
Town of Farragut	22,282	$ 2,072,226
Total	**456,132**	**$ 42,420,276**

Table 3.9 Claims Paid in Knox County for Crop Loss as a Result of Drought (2007-2016)

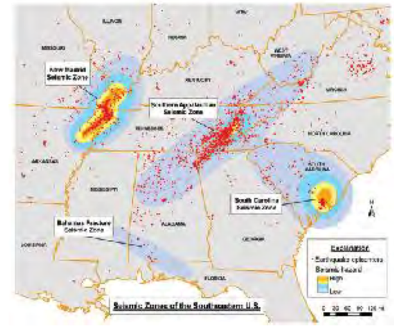
Year	Crop	Hazard	Claims Paid
2010	All Other Crops	Drought	$3,715
2007	All Other Crops	Drought	$5,156
		Total	$8,871

Source: USDA Risk Management Agency, 2017

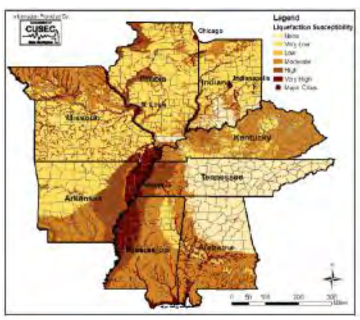
- $8,871 loss over 10-year period
- Adjust for 83% insured = total loss of $10,687
- Annualized loss = $1,068
- Based on value of crops (loss/value) = 0.01%

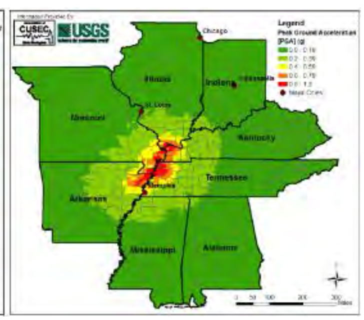
Earthquake

- East Tennessee Seismic Zone within the Southern Appalachian Seismic Zone
- One to two earthquakes with magnitudes equal to or greater than 3.0 are expected in the SASZ per year.



Earthquake

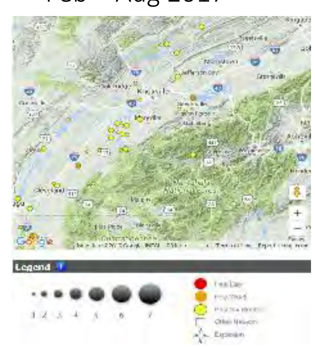




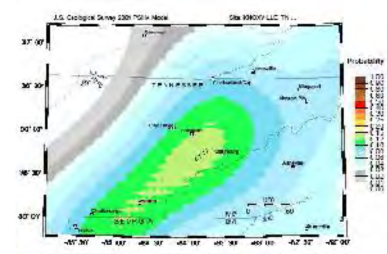
Ground Motion Maps for magnitude 7.7 earthquake

Earthquake

- Previous Occurrences Feb – Aug 2017

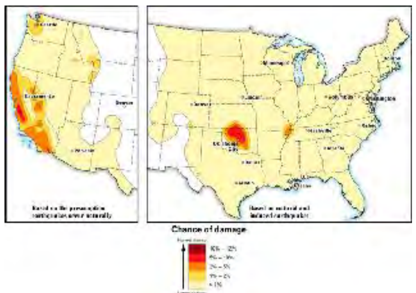


- Probability



Earthquake

- 2017 One Year Model
- High seismic hazard (greater than 1% probability of potentially damaging ground shaking in one year)



Earthquake

- ✓ Spatial Extent: Extensive, 50-100% of planning area
- ✓ Previous Occurrences: Knox Area – Since 1989, recent earthquakes near Knox County have not exceeded a 2.7 magnitude; No structural damage
- ✓ Probability: Likely, 10-100% chance of occurrence
- ✓ Magnitude/Severity: 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

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	3-Likely	1-Negligible	3- Extensive	2.3 (Medium)
Knox County (Unincorporated)	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)

Earthquake

2017 Plan Update

- ✓ No significant changes to hazard profile, utilized 2014 National Seismic Hazard Map
- ✓ Changing Future Conditions
  - The relationship between earthquakes and changing climate conditions is still very new research. However, early research suggests increased flooding and rain causing landslides and erosion could potentially increase fault activities by reducing the weight on a fault or by loosening fault planes, allowing it to move more easily. If precipitation increases to more frequent torrential rain events, the risk of earthquakes could also increase.
- ✓ Building codes and structural retrofits

Risk Assessment

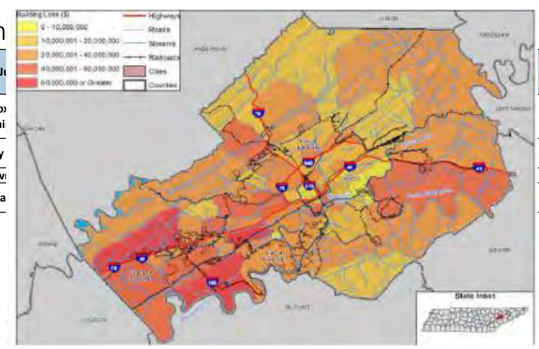
- Earth

Knox (Uni

City

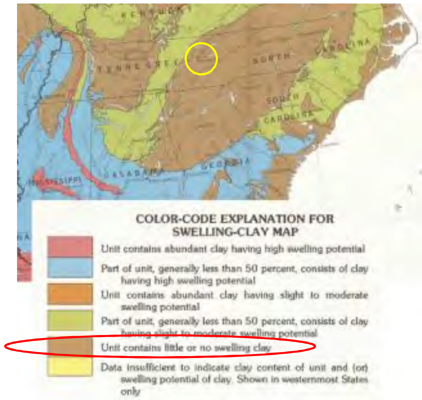
Tow

Tota



Expansive Soils

- Contain minerals such as smectite clays
- Expand when water is added, and shrink when they dry out



Expansive Soils

- ✓ Spatial Extent: Limited, less than 10% of planning area
- ✓ Previous Occurrences: None reported
- ✓ Probability: Unlikely, <1% chance of occurrence
- ✓ Magnitude/Severity: 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.

Probability	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)

Expansive Soils

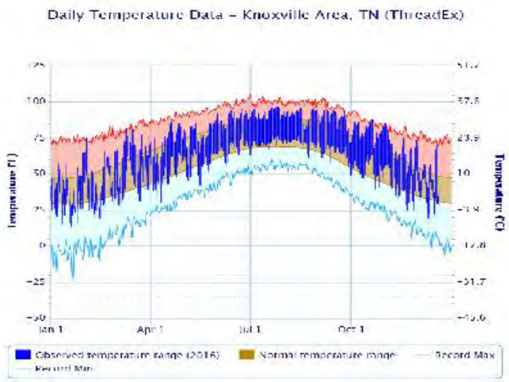
2017 Plan Update

- ✓ No significant changes to hazard profile
- ✓ Changing Future Conditions
  - With limited amounts of clay soil, it is unlikely that damage or frequency of events would increase or decrease.
- ✓ Soil analysis for construction projects

Extreme Temperatures

- Summer Average High - 87°
  - Temperatures consistently stay 10° above average high temperature
- Winter Average Low - 31°
  - Wind Chill Advisory when temperatures are expected to reach –5°F to –14°F and winds of greater than 10 mph for at least 3 hours.
- Urban areas develop and buildings and roads replace open land and vegetation, urban regions become warmer than their rural surroundings, forming an "island" of heat.
- Persons over 65 and under 5 yrs are especially vulnerable.
- Knoxville-Knox County Excessive Heat Plan

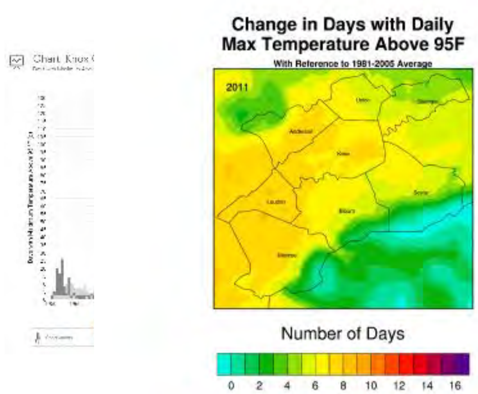
Extreme Temperatures



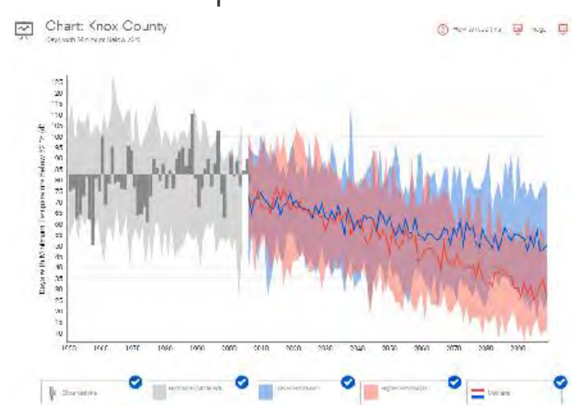
Extreme Temperatures

- Summer Average High - 87°
  - Temperatures consistently stay 10° above average high temperature
- Winter Average Low - 31°
  - Wind Chill Advisory when temperatures are expected to reach –5°F to –14°F and winds of greater than 10 mph for at least 3 hours.
- Urban areas develop and buildings and roads replace open land and vegetation, urban regions become warmer than their rural surroundings, forming an “island” of heat.
- Persons over 65 and under 5 yrs are especially vulnerable.
- Knoxville-Knox County Excessive Heat Plan
- https://toolkit.climate.gov/climate-explorer2/

Extre



Extreme Temperatures



Extreme Temperatures

- ✓ Spatial Extent: High - 50-100% of planning area of the total population adversely affected should the hazard occur
- ✓ Previous Occurrences: January 1, 1950 to August 23, 2017, temperatures above 90 degrees Fahrenheit occurred an average of 34 times each year while temperatures below 10 degrees Fahrenheit occurred an average of 2.5 times per year.
- ✓ Probability: Highly Likely - Near 100% probability in next year.
- ✓ Magnitude/Severity: 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.

Probability	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)

Extreme Temperatures

2017 Plan Update

- ✓ Updated profile with data from Oak Ridge National Lab
- ✓ Changing Future Conditions
  - Heat: In the Southeast, maximum temperatures have not been increasing compared to other parts of the U.S. However, the warm minimum temperature has been increasing meaning that during warmer parts of the year, the coldest days are getting warmer. This is important because human health relies on cooler nights and cooler nights are going away. Changing future conditions also influence heat waves. Models predict there will be more heat wave events and they will last longer with more consecutive days.
  - Cold: With changing future conditions, it is predicted that there will be a decrease in cold air outbreaks.

Risk Assessment

- Extreme Temperature

Jurisdiction	# Age 65 and Over	% Age 65 and Over	# Age Under 5	% Age Under 5	% Individuals Below Under 5 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

Table 3.15 Claims Paid in Knox County for Crop Loss as a Result of Frost/Freeze (2007- 2016)

Year	Crops	Hazard	Claims Paid
2016	All Other Crops	Freeze	$13,420.00
[illegible]	All Other Crops	Frost	$1,032.00
201[illegible]	All Other Crops	Frost	$388.00
201[illegible]	All Other Crops	Freeze	$388.00
[illegible]	All Other Crops	Freeze	$[illegible]
		Total	$28,825

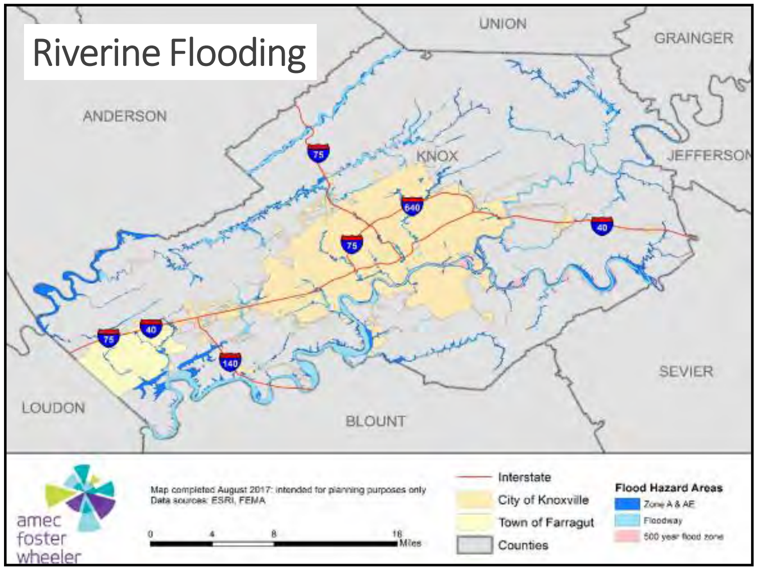
Source: USDA Risk Management Agency, 2017

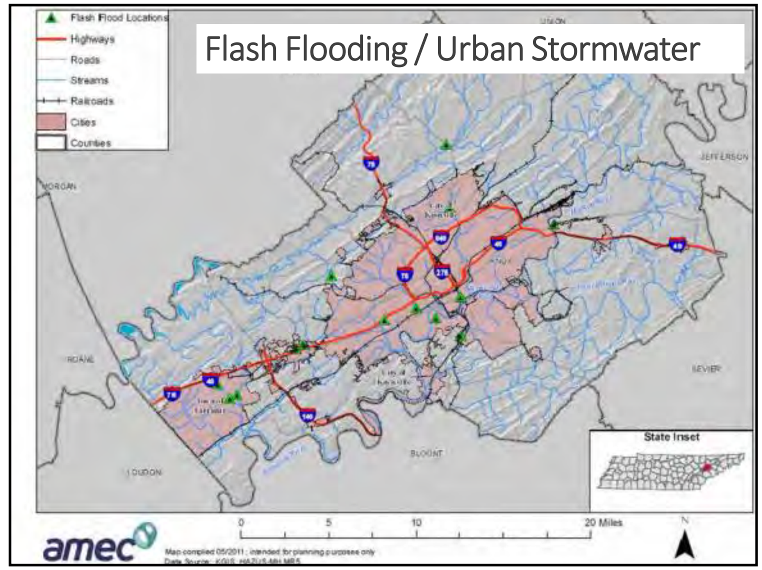
- $28,825 loss over 10-year period
- Adjust for 83% insured = total loss of $34,729
- Annualized loss = $3,473
- Based on value of crops (loss/value) = 0.04%

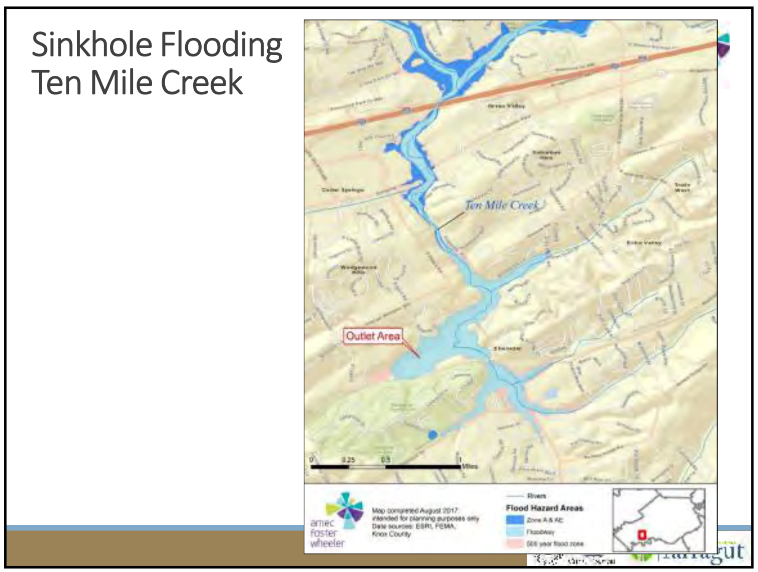
Flood

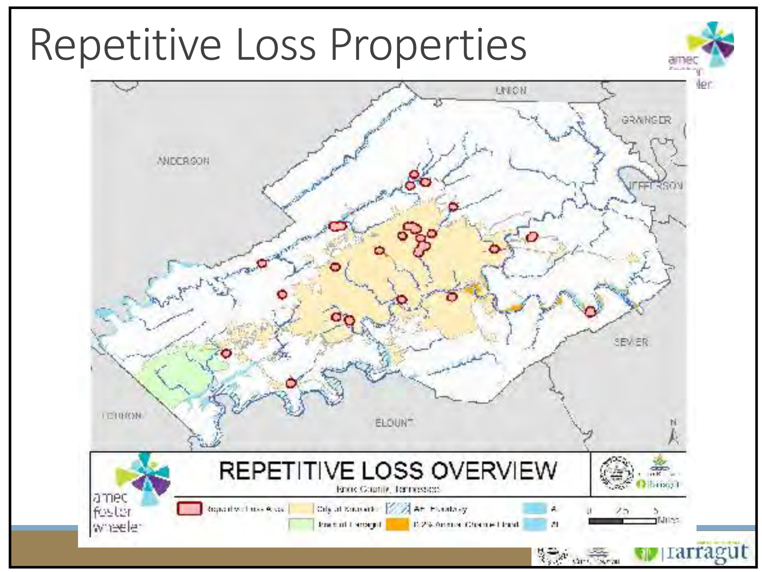
Floods are among the most frequent and costly natural disaster in terms of human hardship and economic loss

- ✓ Riverine – an event when a watercourse exceeds its "bank-full" capacity and is the most common type of flood event. Riverine floods result from precipitation over large areas.
- ✓ Flash Flooding – localized floods of great volume and short duration
- ✓ 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.
- ✓ Urban Stormwater – land loses its ability to absorb rainfall as it is converted from fields or woodlands to roads, buildings, and parking lots


Riverine Flooding
UNION
GRAINGER
ANDERSON
KNOX
JEFFERSON
SEVIER
LOUDON
BLOUNT
amec foster wheeler
Map completed August 2017: intended for planning purposes only
Data sources: ESRI, FEMA
Interstate
City of Knoxville
Town of Farragut
Counties
Flood Hazard Areas
Zone A & AE
Floodway
500 year flood zone
Miles


Flash Flooding / Urban Stormwater
Flash Flood Locations
Highways
Roads
Streams
Railroads
Cities
Counties
State Inset
0
5
10
20 Miles
amec


Sinkhole Flooding
Ten Mile Creek
Ten Mile Creek
Outlet Area
Flood Hazard Areas


Repetitive Loss Properties
UNION
GRAINGER
ANDERSON
JEFFERSON
SEVIER
BLOUNT
REPETITIVE LOSS OVERVIEW
amec foster wheeler
Farragut

RLP Statistics

Repetitive Loss: Any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978. Two of the claims paid must be more than 10 days apart but, within 10 years of each other. A repetitive loss property may or may not be currently insured by the NFIP.

Severe Repetitive Loss: As defined by the Flood Insurance Reform Act of 2004, SRLs are 1-4 family residences that have had four or more claims of more than $5,000 or at least two claims that cumulatively exceed the building's value. The Act creates new funding mechanisms to help mitigate flood damage for these properties.

Number of Properties	17	36
Number of Losses	45	107
Average Payment	$12,111	$22,968
Building Payments	$461,611.76	$1,862,167.35
Contents Payments	$83,414.82	$595,513.11
Total Payments	$545,026.58	$2,457,680.46

Flood

- ✓ Location: Extensive – 50-100% of planning area
- ✓ Previous Occurrences: - From 1997 to 2017, there were 42 records of flood or flash flood events. The average number of flood and flash flood events calculates to 4.2 per year.
- ✓ Probability: Highly Likely - Near 100% probability in next year.
- ✓ Magnitude/Severity: 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.

Probability	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)

Flood

2017 Plan Update

- ✓ Updated previous occurrences; utilize updated DFIRM data for risk assessment; updated repetitive loss information
- ✓ Changing Future Conditions
  - an increase in global temperatures;
  - an increase in heavier precipitation due to increase in evaporation and since warmer air can hold more moisture.
  - Increasing frequency and intensity of heavy rainfall is expected which increases the risk of flooding.
- ✓ Address repetitive loss properties and associated areas; noted flash flooding/urban stormwater problem areas; identify areas of mitigation interest

Risk Assessment

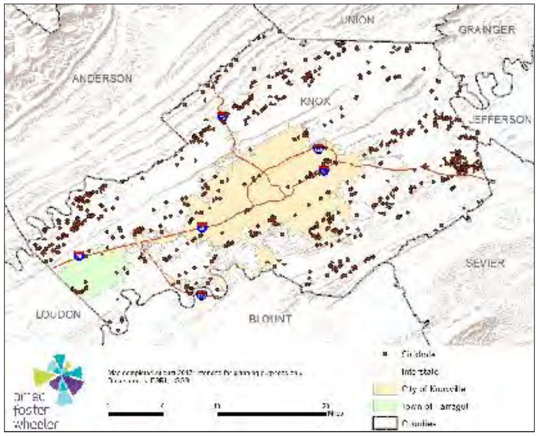
- Flood - EXAMPLE

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

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

Land Subsidence/Sinkholes

- Ground above a manmade or natural void collapses
- Gradual settling or sudden sinking
- Areas of karst have greater risk.



Land Subsidence

- ✓ **Spatial Extent:** Significant – 10-50% of planning area
- ✓ **Previous Occurrences: –** During the period from 2000-2017, there were six documented damaging sinkholes.
  - **Probability:** Likely: Between 10 and 100% probability in next year or at least one chance in ten years.
- ✓ **Magnitude/Severity:** Limited — In general, when sinkholes occur, impacts are limited to a fairly small area and the magnitude of damages is "limited."

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	3-Likely	2-Limited	2-Significant	2.45 (Medium)
Knox County (Unincorporated)	3-Likely	2-Limited	2-Significant	2.45 (Medium)
City of Knoxville	3-Likely	2-Limited	2-Significant	2.45 (Medium)
Town of Farragut	3-Likely	2-Limited	1-Limited	2.25 (Medium)

Land Subsidence

2017 Plan Update

- ✓ Update probability to "likely"
- ✓ Changing Future Conditions
  - – Changing in future conditions raise the likelihood of extreme weather, meaning the torrential rain and flooding conditions which often lead to the exposure of sinkholes are likely to become increasingly common. Certain events such as a heavy precipitation following a period of drought can trigger a sinkhole due to low levels of groundwater combined with a heavy influx of rain.
- ✓ Manage development in sinkhole areas; consider subsidence during building design, monitor areas at risk

Risk Assessment

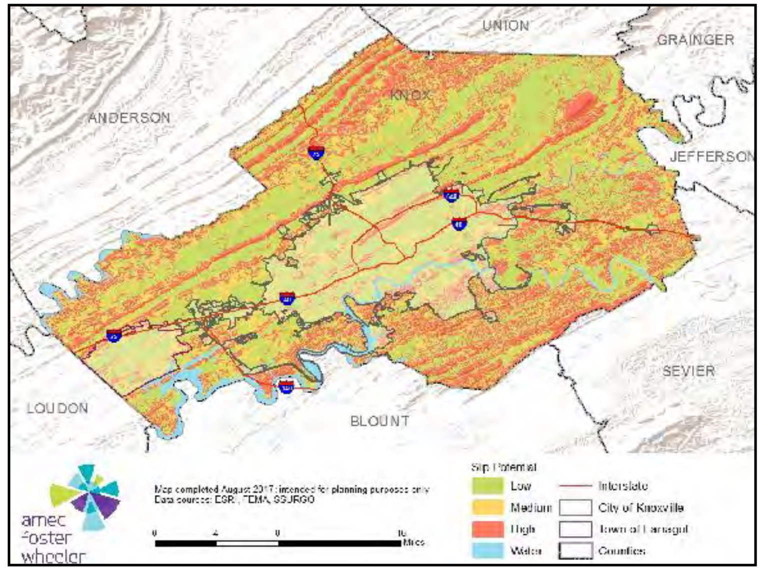
- Land Subsidence/Sinkholes

Knox County									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	727	32	9	389	10	32	7	24	1230
Cost of Building	$ 167,040,600	$ 38,793,500	$ 21,883,400	$ 22,257,700	$ 1,079,700	$ 302,900	$23,331,400	$ 420,200	$ 275,109,400
Acres	4,086.92	371.73	658.79	13,887.42	98.90	1,553.59	308.94	299.99	21,266.28
City of Knoxville									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	171	17	3	54	6	15	6	6	278
Cost of Building	$ 43,795,600	$ 31,312,200	$ 1,020,800	$ 1,225,200	$ 1,078,200	$ -	$19,602,800	$ 115,700	$ 275,109,400
Acres	528.31	137.13	27.47	556.62	48.39	647.14	215.95	54.81	2,215.82
Town of Farragut									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	17	3	0	6	0	0	0	0	26
Cost of Building	$ 12,119,400	$ 5,250,100	$ -	$ -	$ -	$ -	$ -	$ -	$ 17,369,500
Acres	32.33	13.36	0.00	232.25	0.00	0.00	0.00	0.00	277.93

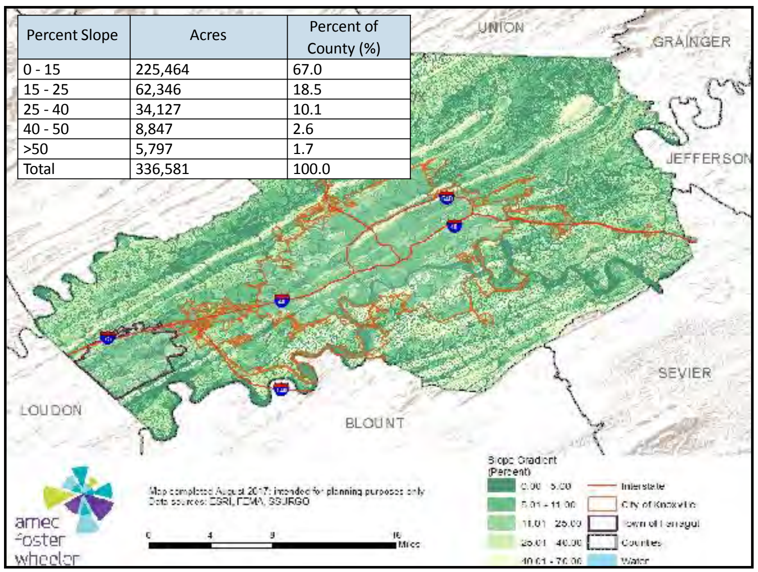
Landslides

- The movement of a mass of rock, debris, or earth down a slope by force of gravity is considered a landslide.
- Landslides occur when the slope or soil stability changes from stable to unstable, which may be caused by earthquakes, storms, volcanic eruptions, erosion, fire, or additional human-induced activities.
- Slopes greater than 10 degrees are more likely to slide, as are slopes where the height from the top of the slope to its toe is greater than 40 feet.
- Knoxville-Knox County Hillside and Ridgetop Protection Plan

farragut



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



Landslides

- ✓ Spatial Extent: Significant - 10-50% of planning area
- ✓ Previous Occurrences: Two documented damaging events in the 16-year period from 2000-2017 = 11.1% probability. In addition, it is probable that other smaller scale slides may have occurred that were not reported.
- ✓ Probability: Likely - Between 10 and 100% probability in next year

  Magnitude/Severity: 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.

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	3-Likely	2-Limited	2-Significant	2.45 (Medium)
Knox County (Unincorporated)	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)

Landslides

<u>2017 Plan Update</u>

- ✓ Incorporation of slip potential and slope gradient data
- ✓ Changing Future Conditions
  - – Future conditions expect an increase in heavy rainfall which can lead to more erosion and landslides. The expansion of urban and recreational developments into hillside also puts more people at risk of landslides. Since landslides commonly occur along with other natural disasters like floods, there is a possibility of more landslides due to the increasing threat of flooding.
- ✓ Manage development in high hazard areas

Risk Assessment

- Landslide – Soil Slip, High Potential

Knox County									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	37545	780	257	10868	269	434	34	1172	51359
Cost of Building	$ 6,459,722,000	$ 722,876,700	$196,046,200	$ 230,334,100	$35,590,000	$ 42,601,000	$57,419,300	$ 29,407,200	$ 7,773,996,500
Acres	78,234.16	4,605.83	3,024.81	98,768.76	1,497.97	8,481.37	653.19	3,962.05	199,228.15
City of Knoxville									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	11581	442	129	3575	120	321	19	257	16444
Cost of Building	$ 2,211,758,800	$ 485,200	$ 2,934,000	$ 65,824,300	$18,706,500	$ 829,300	$ -	$ 1,156,400	$ 2,301,694,500
Acres	15276.91	2563.81	1325.00	14547.65	864.62	4733.29	365.59	945.56	40622.44
Town of Farragut									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	1842	28	16	403	5	8	3	154	2459
Cost of Building	$ 489,935,900	$ 69,022,500	$ 58,417,700	$ 83,278,300	$ -	$ 186,100	$ 662,000	$ 278,400	$ 701,780,900
Acres	1,597.86	292.42	1,341.09	3,021.39	24.10	202.41	5.47	304.02	6,788.75

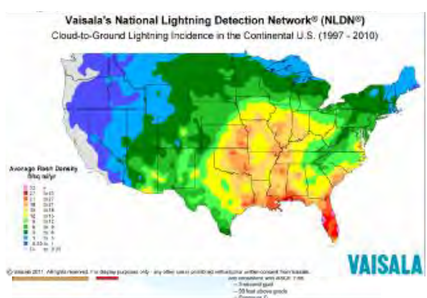
Risk Assessment

- Landslide – Slope Class

Knox County									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	7018	183	68	3034	49	109	6	177	10644
Cost of Building	$ 1,423,177,500	$ 146,678,000	$ 23,587,600	$ 77,546,700	$ 8,159,500	$ 2,858,700	$ 8,429,600	$ 17,672,800	$ 1,708,110,400
Acres	25083.64	1394.02	1124.50	38319.12	520.07	3863.18	98.79	1381.83	71785.16
City of Knoxville									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	2904	144	46	1201	21	78	4	69	4467
Cost of Building	$ 672,090,800	$ 135,427,200	$ 21,651,000	$ 17,978,300	$ 6,872,500	$ 2,764,700	$ -	$ 3,107,000	$ 859,891,500
Acres	5572.41	1006.56	705.46	5121.56	363.01	2529.51	28.32	388.41	15715.25
Town of Farragut									
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	3	0	0	2	0	0	0	1	6
Cost of Building	$ 1,215,600	$ -	$ -	$ 7,300	$ -	$ -	$ -	$ -	$ 1,222,900
Acres	30.23	0.00	0.00	47.80	0.00	0.00	0.00	53.75	131.78

Severe Storms

- Localized storms accompanied by hail, high winds, lightning, heavy rain causing flash flooding and sometimes tornadoes.



- Power outages from downed power lines. Manufactured homes, campers and light buildings at increased risk of damages.

Severe Storms

- ✓ **Spatial Extent:** Extensive - 50-100% of planning area
- ✓ **Previous Occurrences (Since 2001):**
  - **High Wind** – 29 Severe thunderstorms with high wind
  - **Hail** – 97 events
  - **Lightning** – 6 events
- ✓ **Probability:** Highly Likely - Near 100% probability in next year.
- ✓ **Magnitude/Severity:** 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.

Probability	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)

Severe Storms

2017 Plan Update

- ✓ Update to previous occurrences
- ✓ Changing Future Conditions
  - – Hail: Future atmospheric conditions are predicted to have more CAPE and a decrease in wind shear. An increase in CAPE and decrease in wind shear are not favorable environments for hail. It may appear to be an increase in hail events or increase in damage caused by hail over the last decade but there is a bias since reporting and data collection for hail data began in 1950.
  - – High winds: Wind speeds have increased globally over the past 20 years; however, it is not clear whether it is due to climate change or if it's part of a cyclical pattern.

Severe Storms

2017 Plan Update

- ✓ Changing Future Conditions
  - – Lightning: With atmospheric conditions favoring more CAPE there is a possibility for more storms. However, there it is still debate about whether there will be an increase or decrease with most research favoring an increase in CAPE and precipitation resulting in more lightning events. Most possible impacts are focused around forest fire implications.
- ✓ Include public awareness; insurance; protect critical facilities and equipment from lightning damage; building codes to address wind damage; public survey noted concern for downed trees

Risk Assessment

- Severe Storms

Jurisdiction	Population (2016)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
Knox County (Unincorporated)	**247,611**	24761.1	$ 3,119,899
City of Knoxville	**186,239**	18623.9	$ 2,346,611
Town of Farragut	**22,282**	2228.2	$ 280,753
Total	**456,132**	45613.2	$ 5,747,263

Tornado

- A tornado is a violently rotating column of air that has contact with the ground and is often visible as a funnel cloud.
- The destruction caused by tornadoes ranges from light to catastrophic depending on the intensity, size, and duration of the storm.

Tornado

Tornado

- ✓ Spatial Extent: <u>Limited</u> - Less than 10% of planning area
- ✓ Previous Occurrences (Since 1950): 15 tornado events; 7 were rated F0, 5 were rated F1, 2 were rated F2, 1 was rated F3.
- ✓ Probability: <u>Likely</u> - Between 10 and 100% probability in next year or at least one chance in ten years.
- ✓ Magnitude/Severity: <u>Limited</u> — 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.

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	3-Likely	2-Limited	1-Limited	2.25 (Medium)
Knox County (Unincorporated)	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)

Tornado

<u>2017 Plan Update</u>

- ✓ Update previous occurrences and mapping of paths; adding info on timing of tornado events
- ✓ Changing Future Conditions
  - – Current research suggests an increase in more tornadoes outbreaks due to changing heat and moisture content in the atmosphere brought on by a warming world. The number of days with large outbreaks has been increasing since the 1950s, but areas that normally see tornado activity are not expanding. Therefore, it should be expected to see more tornadoes on fewer days in areas that already experience tornadoes.
- ✓ Safe room construction; building codes addressing wind resistance; public awareness; warning capabilities

Risk Assessment

- Tornado

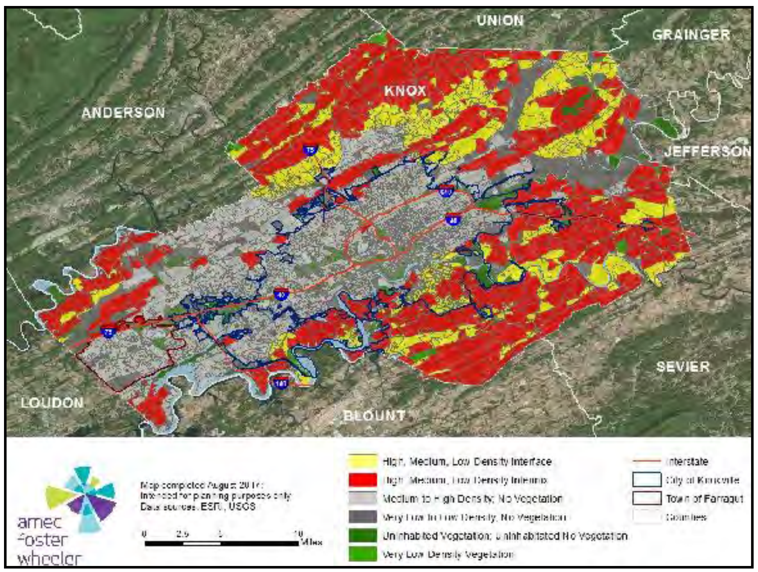
Jurisdiction	Land Area (Sq.Mi.)	Housing Density	Housing in 0.653 Sq. Mi.	Avg. Home Value	Value of Exposed Homes
Knox County (unincorporated)	526	337	22	$147,200	$3,238,400
City of Knoxville	104	917	60	$109,600	$6,576,000
Town of Farragut	16.09	412	27	$293,900	$7,935,300
Total					$17,749,700

Wildfire

- Uncontrolled fire in combustible vegetation that occurs in the countryside or wilderness area

Year	# Fires	Acres Burned
2005	6	21
2007	16	513
2008	7	110
2009	11	177
2010	6	19
Totals	46	840

- WUI – Interface/Intermix Area
  - Intermix communities are places where housing and vegetation intermingle. In intermix, more than 50 percent vegetation and more than 1 house per 16 ha.
  - Interface communities are areas with housing in the vicinity of contiguous vegetation. Interface areas have more than 1 house per 40 acres, have less than 50 percent vegetation, and are within 1.5 mi of an area (made up of one or more contiguous Census blocks) over 1,325 acres (500 ha) that is more than 75 percent vegetated.



Wildfire

- ✓ Spatial Extent: <u>Limited</u> – Between 10% to 25% of the total population adversely affected should the hazard occur
- ✓ Previous Occurrences: Occur on annual basis, TN Dept of Forestry
- ✓ Probability: <u>Highly Likely</u> - Near 100% probability in next year.
- ✓ Magnitude/Severity: <u>Negligible</u> — 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

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	4-Highly Likely	1-Negligible	1-Limited	2.35 (Medium)
Knox County (Unincorporated)	4-Highly Likely	1-Negligible	3-Extensive	2.75 (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)

Wildfire

2017 Plan Update

- ✓ Update previous occurrences and WUI mapping
- ✓ Changing Future Conditions
  - – Drought is anticipated to increase in frequency and intensity during summer months under projected future scenarios. Drought can lead to dead or dying vegetation which creates fodder for wildfires within both urban and rural settings. Higher temperatures also reduce the number of days prescribed burning can be performed. Also an increase in the wildland-urban interface puts more people in threat of wildfires. Reduction of prescribed burning will allow growth of understory vegetation, providing more fuel for destructive wildfires.
- ✓ Land use planning; fire-resistant construction practices; defensible space

Risk Assessment

- Wildfire – Intermix

Knox County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	23801	325	141	7298	203	148	9	674	32599
Cost of Building	$ 3,343,389,500	$ 114,954,000	$ 53,908,500	$ 154,473,200	$21,058,500	$ 1,714,400	$ 802,800	$ 17,338,200	$ 3,707,639,100
Acres	61072.47	1553.04	1436.21	70654.39	713.22	3914.11	173.66	2089.67	141606.78
City of Knoxville	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	7744	135	42	2306	58	98	3	189	10575
Cost of Building	$ 1,240,287,800	$ 67,209,800	$ 4,755,800	$ 32,752,400	$13,652,100	$ 1,154,800	$ 334,600	$ 1,523,000	$ 1,361,670,300
Acres	12452.63	580.83	199.38	11298.76	250.08	2240.36	133.24	409.32	27564.61
Town of Farragut	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	200	0	4	91	0	0	1	12	308
Cost of Building	$ 51,770,800	$ -	$ -	$ 3,822,900	$ -	$ -	$ 193,500	$ -	$ 55,787,200
Acres	408.87	0.00	38.64	1056.52	0.00	0.00	3.79	86.60	1594.41

- Wildfire - Interface

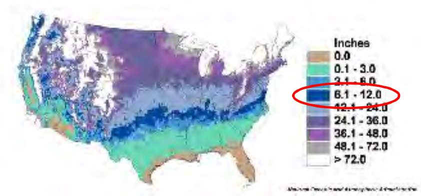
Knox County	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	25438	530	118	4192	175	191	9	409	31062
Cost of Building	$ 3,137,322,400	$ 168,822,100	$ 98,745,800	$ 89,887,800	$13,733,400	$ 6,356,400	$ 2,780,900	$ 29,363,200	$ 3,547,012,000
Acres	28601.36	1202.45	1245.54	35107.34	590.16	3865.38	55.34	1341.82	72009.40
City of Knoxville	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	7533	267	62	1193	65	123	2	80	9325
Cost of Building	$ 826,548,900	$ 103,761,300	$ 63,919,800	$ 8,793,600	$ 2,310,600	$ 3,201,000	$ 69,900	$ 4,276,900	$ 1,012,882,000
Acres	4984.10	582.33	414.50	37138.93	169.63	1962.63	4.42	160.24	45416.78
Town of Farragut	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Other	Total
Number of Building	0	0	0	0	0	0	0	0	0
Cost of Building	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Acres	0	0	0	0	0	0	0	0	0

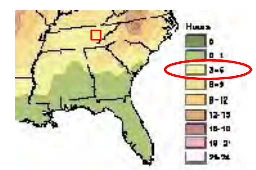
Severe Winter Storms

- Winter storm conditions include:
  - – **Blizzard**—Winds of 35 mph or more; reduced visibility to less than 1/4 mile for ~3 hours.
  - – **Blowing Snow**—Wind-driven snow that reduces visibility.
  - – **Snow Squalls**—Brief, intense snow showers accompanied by strong, gusty winds.
  - – **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. **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.
- Property damage, power, phone outages, and closures of streets, highways, schools, businesses, and nonessential government operations

Severe Winter Storms

Annual Mean Total Snowfall





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://wf.ncdc.noaa.gov/oa/climate/online/ccd/snowfall.html

Severe Winter Storms

- ✓ Spatial Extent: Extensive - 50-100% of planning area
- ✓ Previous Occurrences (1993-2017): 39 recorded winter storm events (snow and ice) in the planning area resulting in an average of one and a half winter storms per year.
- ✓ Probability: Highly Likely - Near 100% probability in next year.
- ✓ Magnitude/Severity: 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

Probability	Probability	Magnitude	Spatial Extent	Significance
Planning Area Overall	4-Highly Likely	1-Negligible	3-Extensive	2.75 (Medium)
Knox County (Unincorporated)	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)

Severe Winter Storms

2017 Plan Update

- ✓ Updated previous occurrences and winter precipitation
- ✓ Changing Future Conditions
  - During the last century, the South has seen a reduction in snowstorm frequency. It is predicted that in a changing climate that there will be continue to be fewer snowstorms in the South.
- ✓ Protect power lines and reduce impacts to roadways; public education and outreach; assistance to vulnerable populations

Risk Assessment

- Winter Storm

Jurisdiction	Population (2016)	Estimated Affected Population (10%)	Electric Loss of Use Estimate ($126 per person per day)
Knox County (Unincorporated)	**247,611**	24761.1	$ 3,119,899
City of Knoxville	**186,239**	18623.9	$ 2,346,611
Town of Farragut	**22,282**	2228.2	$ 280,753
Total	**456,132**	45613.2	$ 5,747,263

Let's Take a Break?

COMMUNITY MEETING

SEPT.

Sign-In Sheet – ~~July 11~~, 2017

Name	Title	Department	Email	Phone
Ron Williams	Farragut Alderman		rwilliams@townoffarragut.org	318-9017
Erin Gill	Sustainability -	City of Knoxville	egill@knoxvilletn.gov	865 215 4436
David McGinley	Engineering Manager	COK	DMcGinley@KnoxvilleTN.Gov	215-2072
Courtney Shea	Steering Committee	TIPL	courtshea@aol.com	387-7466
Louis Gomple	Committee Chair	Naacp	Lgomple@gmail	441-7752
John Butler	President	Knoxville Branch NAACP	johnanthonybutler@gmail.com	865 617-2603
Cynthia Finch	New Direction Health Care Solution	Connect Ministries	cynthiafinch@gmail.com	865-254-4493
EDDY ROBERTS	KNOX COUNTY	STORMWATER	eddy.roberts@knoxcounty.org	865 215-5234
DAVID MASSEY	Neighborhood Coordinator	City of Knoxville	dMassey@KnoxvilleTN.gov	215-3232

Knoxville Tennessee Branch

NAACP

August 25, 2017

To whom it may concern:

The Knoxville Branch of the NAACP approved the following resolution at its August 3, 2017 meeting:

As summers in Knoxville are getting increasingly hotter,

As the health consequences of extreme heat can be deadly and pose serious health risks,

As high night temperature is a major factor of heat stress,

As many do not have the resources to escape deadly heat,

As Knoxville/ Knox County Hazard Mitigation Planning Committee is presently updating the "Multi-Jurisdictional Local Hazard Mitigation Plan,

Be it resolved that the Knoxville Branch of the NAACP urges the Hazardous Mitigation Planning Committee to develop a mitigation plan to reduce the health risks of extreme temperatures among vulnerable populations within Knox County.

Date

Name
Title
Address
City, State Zip

RE: Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan

Dear

Knox County, Tennessee; the City of Knoxville, and the Town of Farragut are updating the Multi-Jurisdictional Local Hazard Mitigation Plan to better protect the people and property of the communities from the effects of natural hazard events. The plan will be updated pursuant to the requirements of the Disaster Mitigation Act of 2000 and the implementing regulations set forth in the Federal Register (44 CFR §201.6). These regulations establish the standards for hazard mitigation plans to allow plan owners eligibility to access funds for federal disaster assistance and hazard mitigation, under the Robert T. Stafford Disaster Relief and Emergency Act. In addition, the mitigation planning process will incorporate the 10-steps of Activity 510-Floodplain Management Planning in the National Flood Insurance Program's (NFIP) Community Rating System (CRS) Program.

The County has contracted Amec Foster Wheeler to facilitate the planning process and prepare the plan document. On July 11, 2017, a kick-off meeting was held with the Hazard Mitigation Planning Committee to organize the planning effort, prepare for public involvement in the planning process, and initiate coordination with other agencies and stakeholders.

We are reaching out to other agencies and stakeholders, such as you, to coordinate with those who may bring additional information to the planning process and associated flood/hazard issues within Knox County. Any information, studies, etc. which may supplement the work of the established Hazard Mitigation Planning Committee would be welcomed. In addition, I invite you to participate in our committee and public meetings throughout the planning process.

As the program manager for this project I can be reached at (865) 215-5234; eddy.roberts@knoxcounty.org; or you may send information directly to my attention to the address on this letterhead. You are also welcome to contact our planning consultant, Ms. Cindy Popplewell with Amec Foster Wheeler at (615) 333-0630 or cindy.popplewell@amecfw.com.

We look forward to hearing from you and/or your participation at future committee and public meetings.

Thank you,

Eddy Roberts,
Knox County Department of Engineering & Public Works

APPENDIX C
MITIGATION ALTERNATIVES

The following information was presented to the HMPC as a handout during in Meeting #3 to identify and prioritize mitigation actions.

Categories of Mitigation Actions

FEMA's publication *Developing the Mitigation Plan* emphasizes the following six categories of mitigation activities and examples:

1. Prevention: Administrative or regulatory actions/processes that influence the way land and buildings are developed and built.

- Building codes and enforcement
- Floodplain development regulations
- Open space preservation
- Stormwater management regulations

2. 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 of hazard prone structures
- Construction of barriers around structures
- Elevation of structures
- Relocation out of hazard areas

3. Public Education and Awareness: Actions to inform and educate citizens, elected officials, and property owners about the hazards and potential ways to mitigation them.

- Public education and outreach programs
- Real estate disclosure
- Flood insurance
- Hazard Information Centers

4 Natural Resource Protection: Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems.

- Best Management Practices (BMPs)
- Forest and vegetation management

- Hydrological Monitoring
- Urban forestry and landscape management

5. Emergency Services: Actions that protect people and property during and immediately after a disaster or hazard event. Protection of critical facilities

- Critical facilities protection
- Emergency response services
- Hazard warning systems
- Hazard threat recognition

6. Structural Projects: Actions that involve the construction of structures to reduce the impact of hazard.

- Channel maintenance
- Dam/reservoirs
- Levees/floodwalls
- Safe rooms/shelters

Not all of the mitigation actions presented to and/or discussed by the HMPC at Meeting #3 and the public open house became recommended action items. Action items may not have been considered to be cost-effective or support the community's goals. Additionally, action items may have lacked political support, constituent support, and funding. Action items not recommended or included in the priority list are presented in Table C.1. In addition, actions items identified in the 2011 *Knox County, City of Knoxville, and Town of Farragut Multi-Jurisdictional Local Hazard Mitigation Plan* that have been completed or were not carried forward are presented in Table C.1.

Table C.1. Alternative Mitigation Actions

Action	Source	Status
Secure funding for construction of regional detention basins.	2011 Plan	Removed, lack of support.
First Creek Improvements – Walker Blvd	2011 Plan	Completed
Cross Park Drive drainage	2011 Plan	Completed
First Creek Improvements – North of Tecoma	2011 Plan	Completed
4th Creek – Northshore Bridge Improvements	2011 Plan	Completed
Cherry Street Sinkhole Maintenance	2011 Plan	In Progress; working with TDOT to complete. Updated mitigation actions to general drainage maintenance.
4th Creek Channel Stabilization	2011 Plan	Completed
Prevention/Public education and awareness; radon awareness and testing in homes.	HMPC Meeting #3	Radon not currently addressed as a natural hazard; could include in next update; and incorporate into outreach/public education program at this time
Research options to increase funding for Healthy Homes Program, including radon remediation in low-income homes	HMPC Meeting #3	Radon not currently addressed as a natural hazard; could include in next update; and incorporate into outreach/public education program at this time
Prevent future placement of critical facilities in flood zones and other hazardous areas—zoning/land use regulations	HMPC Meeting #3	Already covered under existing ordinances
Don’t allow development on floodplain	HMPC Meeting #3	Addressed through participation in the NFIP
Development of stormwater utility as funding source for mitigation projects	HMPC Meeting #3	Lacks political backing at this time
Mitigation—urban heat island effect	Public Open House	Repeated action item

Action	Source	Status
Regulate to have plans reviewed by soil scientist, environmental review standards	Public Open House	Combined with similar action item
Extreme Temperature: Structural retrofits—codes? Outreach programs; strategic placement of vegetation/vegetation bonds; promote energy efficiency, use natural systems to heat/cool	Public Open House	Incorporated into individual mitigation actions