



UNC CHARLOTTE

TOWN OF DAVIDSON HAZARD ANALYSIS



The Town *of*
Davidson

College Town, Lake Town, Your Town



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EXECUTIVE SUMMARY

The Town of Davidson (Davidson) is seeking a Community Risk Reduction (CRR) plan in the interest of improving preparedness for incidents that could threaten the safety and security of its citizens. The Davidson Fire Department will look to utilize the CRR plan in order to achieve accreditation through the Center for Public Safety Excellence (CPSE). Davidson enlisted the assistance of students of the Gerald G. Fox Master of Public Administration program (the MPA team) at the University of North Carolina at Charlotte with the initial steps in creating a CRR plan. These steps include identifying and prioritizing potential hazards to Davidson by conducting a Community Risk Hazard Analysis. Although covered under the Multi-Jurisdictional Hazard Mitigation Plan conducted for Mecklenburg County, the development of a CRR plan will allow Davidson to more specifically address hazards unique to the town. Davidson will use the information provided in this report to aid in community safety efforts.

Methods

The MPA team used various methods to conduct this hazard analysis and vulnerability assessment. These include:

- Extensive literature review of risk assessment and disaster management best practices
- Interviews with Davidson, Mecklenburg County, and State of North Carolina officials
- Quantitative analysis of incident reporting and GIS mapping of critical locations and incidents
- Qualitative analysis on the Priority Risk Index (PRI)

The results of the MPA team's research are reported in four major sections. These sections are as follows:

Community Profile

The Community Profile provides a broad overview of Davidson. General economic, demographic, and geographic characteristics are discussed. Critical infrastructure is identified, and land use patterns and service call data are examined. This information provides a baseline for identifying potential hazards and at-risk populations within the town.

Risk Identification and Analysis

The Risk Identification and Analysis identifies and prioritizes hazard risks that might affect Davidson. The MPA team identified 17 potential risks to Davidson. To prioritize each of the 17 potential hazards, the MPA team utilized a qualitative analysis tool, the Priority Risk Index (PRI) scale. PRI values are calculated through a weighted assessment across five categories:

1. the **probability** that a hazard will occur;
2. the potential **impact** to the town in terms of injury, loss of life, or property damage;
3. the **spatial extent** or area likely to be affected by the hazard;
4. the expected **warning time** available to prepare for the hazard; and
5. the likely **duration** of the hazard.

Town of Davidson Hazard Analysis



Each of the five categories is assigned a PRI value ranging from one to four, with one being the lowest and four being the highest. Using the PRI value for each category, the overall PRI value for the hazard is assessed using the following equation:

$$PRI\ Value = [(Probability \times .30) + (Impact \times .30) + (Spatial\ Extent \times .20) + (Warning\ Time \times .10) + (Duration \times .10)]$$

Using this PRI scale, the MPA team identified and prioritized 17 potential hazards to Davidson. Table 1.1. rank-orders these hazards based upon their PRI values:

**Table 1.1
Town of Davidson Identified Hazards**

Risk	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Value
Nuclear Reactor Failures	1	4	4	4	4	3.1
Winter Storms	3	3	4	1	3	3.0
Thunderstorms/Hailstorms	4	2	3	4	1	2.9
Fire	4	2	2	4	1	2.7
Hurricanes/Tropical Storms	2	3	4	1	2	2.6
Wildfires	4	1	2	4	2	2.5
Tornadoes	2	3	2	4	1	2.4
Hazardous Material: Pipeline Incident	1	3	2	4	2	2.2
Earthquakes	1	1	4	4	1	2.2
Dam Failures	1	3	2	2	3	2.1
Drought	2	2	2	1	4	2.1
Hazardous Material: Transportation Incident	1	3	2	4	1	2.1
Terrorism & Active Shooter Events	1	3	2	4	1	2.1
Severe Disease Outbreak	1	2	1	4	4	1.9
Flood	2	1	2	3	2	1.8
Sinkholes	1	2	1	4	1	1.6
Landslides	1	1	1	2	1	1.1

Vulnerable Sites

The vulnerable site analysis identifies specific target hazards in four service area zones: West Davidson, East Davidson, Davidson College, and the Extraterritorial Jurisdiction (ETJ). Based upon the nature of specific hazards, the MPA team assessed the zones that may be at higher risk for certain hazards.



Capability Assessment

The Capability Assessment discusses Davidson's ability to respond to potential hazards. Building upon the Capability Assessment completed in 2015 as part of the Mecklenburg County Hazard Mitigation Plan, the MPA team identified further steps that Davidson has taken to better prepare for hazards. Steps of note include increases in personnel for the Fire Department and the construction of a second fire station (set to open in December 2017).



INTRODUCTION

The Town of Davidson (Davidson) enlisted the assistance of students of the Gerald G. Fox Master of Public Administration program at the University of North Carolina at Charlotte with the initial steps in developing a Community Risk Reduction (CRR) plan. These initial steps are the identification and prioritization of potential hazards to Davidson. A full CRR plan identifies and prioritizes local hazards, but also includes the investment of resources to reduce the occurrence and impact of identified hazards. The CRR provides a focused approach to reducing the specific, identified hazards.

Hazards are generally defined as a danger that poses a threat to a vulnerable target. In the case of a municipality such as Davidson, the vulnerable targets could range from critical infrastructure, such as gas pipelines or primary electrical lines, to the citizens themselves. Hazards are potential occurrences that any municipality must understand and adequately plan for to provide safety and security for its citizens.

This report is divided into six sections: Community Profile, Methodology, Risk Identification and Analysis, Vulnerable Sites, Capability Assessment, and Appendices. The *Community Profile* summarizes key economic, demographic, and geographic characteristics of Davidson. It also identifies key infrastructure and land areas that must be prioritized in emergency preparation. The *Methodology* section details the process the MPA team used to collect quantitative and qualitative data on hazard risks. The *Risk Identification and Analysis* section identifies and prioritizes hazard risks that might affect Davidson. The *Vulnerable Sites* section highlights specific target hazards in the four service areas zones that divide Davidson. The *Capability Assessment* discusses Davidson's ability to respond to potential hazards. The *Appendices* provide additional supporting information that is referenced within the report.

In this report, the MPA team identified and prioritized 17 potential hazards of concern for Davidson.



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COMMUNITY PROFILE

History of Davidson

Davidson is a small college town located in the Southern Piedmont region of North Carolina. Davidson's history began with the opening of Davidson College in 1837. From 1837 to 1879, Davidson College acted as the town government. In 1879, the town incorporated as Davidson College, and in 1891, the town officially changed its name to Davidson. Economic stimuli such as the construction of the railroad and various textile plants sparked population growth for Davidson throughout the 19th and 20th centuries. Davidson is currently experiencing rapid population growth along with a shift in demographics as more young families and retirees move to the town (Town History, n.d.-b). Presently, Davidson is the second smallest of the seven incorporated towns in Mecklenburg County with a population of 11,765 (U.S. Census Bureau, 2015).

Topography and Climate

Location

Davidson is located on the northern tip of Mecklenburg County; a small section of the town is in Iredell County. The town encompasses 5.75 square miles, excluding the extraterritorial jurisdiction (ETJ). The ETJ is outside of municipal corporate limits but under the municipality's authority for planning and zoning purposes. The Davidson Fire Department also provides services to the North Star Fire District, which is in the ETJ (Town of Davidson, n.d.-d). Davidson's ETJ is 7.47 square miles of primarily rural space located to the east of the town center. Elevation in Davidson ranges from 700 feet to 838 feet (NC Geographic Information Coordinating Council, n.d.).

Bodies of Water

The largest body of water in Davidson is Lake Davidson, which straddles the Mecklenburg and Iredell County line. Lake Davidson is approximately 341 acres and is part of Lake Norman, but is separated by Interstate-77 (I-77). The town has three public access points: Davidson Bay, South Shore, and Davidson Pointe (Town of Davidson, 2008). Both the Catawba and the Yadkin-Pee Dee river basins are located in Davidson. The West Branch of the Rocky River, its South Prong, and their various tributaries cut through the town, primarily in the southeastern portion. FEMA-designated floodways and floodplains are located along both the West Branch and the South Prong of the West Branch (Charlotte-Mecklenburg Storm Water Services, n.d.).

Climate

In 2016, the average annual temperature in the Southern Piedmont region of North Carolina was 62 degrees. Temperatures in Davidson tend to be highest in July and lowest in January with the average high for July around 89 degrees, and the average low for January around 29 degrees Fahrenheit (State Climate Office of North Carolina, n.d.-b).

The average annual rainfall in Davidson is 44 inches—slightly higher than the average for the Southern Piedmont region, which is 36 inches. Mecklenburg County tends to get the most precipitation in the



months of March, July, and September. The average annual snowfall in Davidson is between two to four inches ((State Climate Office of North Carolina, n.d.-b).

Population, Demographics, and Housing

Racial and Ethnic Demographics

According to the U.S. Census Bureau, Davidson had an estimated population of 11,765 in 2015. Whites comprise the largest racial group in Davidson, representing 86.7% of the population (U.S. Census Bureau, 2015). Additionally, 6.1% of the population identifies as Hispanic or Latino. Other racial groups are depicted in Table 2.1.

Table 2.1
Town of Davidson Racial Demographics

2015 Population Estimate: 11,765		
Race/Ethnicity	Number of People	Percentage of Population
White	10,198	86.68%
Black	1,103	9.38%
American Indian	93	0.8%
Asian	212	1.8%
Other	9	0.07%
Two or more races	150	1.27%

Source: US Census Bureau

Davidson College and its 1,950 students are an important demographic group to the town. Ninety-three percent of students live on campus from August to May. Similar to the racial demographics of the town, the majority of students (75%) identify as white. The campus is home to 115 international students who comprise 5.9% of the student population (Davidson College, n.d.).

High-Risk Populations

Certain sub-populations are considered high-risk due to cultural, economic, or environmental factors, and therefore need special consideration when evaluating hazards and reducing risk. The community risk assessment literature has identified five high-risk populations: children under the age of five, adults over the age of 64, people in poverty, children under the age of five in poverty, and people with disabilities (Stouffer, 2016). Table 8.1 in Appendix A shows population estimates all the high-risk populations in Davidson.



Social Demographics

In Davidson, the majority (72.5%) of households are family households which have two or more people living in the home. The high school graduation rate is 97.4%, which is higher than Mecklenburg County's high school graduate rate of 88.8%. Additionally, 66.9% of residents have earned a bachelor's degree or higher, greater than Mecklenburg County's rate of 40.7% (U.S. Census Bureau, 2015). For Davidson's other important social demographics, see Table 8.2., located in Appendix A.

Housing Demographics

Nearly three-fourths of the 4,264 housing units in Davidson are owner-occupied. The median home value of these owner-occupied units is \$381,200, which is more than double the median value in Mecklenburg County (\$184,000). The vacancy rate is 7.4%, and families occupy approximately two-thirds of homes; nonfamily households in the town are primarily residents who live alone. Thirty-seven percent of households have one or more people under the age of eighteen (U.S. Census Bureau, 2015). Between 2000 and 2010, Davidson grew by 53.5%, while Mecklenburg County grew by 32.3%. As more young families and retirees move to Davidson, the town is experiencing a shift in social demographics and increases in residential construction—specifically single family homes (Town of Davidson, 2017).

Economic Demographics

The median household income for Davidson is \$105,083, substantially higher than Mecklenburg County's median household income of \$56,854. Only 5.7% of families fall below the poverty level. Davidson's highly-educated population, and its proximity to Charlotte and major transportation routes have drawn employers to the town. Davidson has three major employers: Ingersoll-Rand, Davidson College, and MSC Industrial Direct. Together they employ nearly 3,000 people (Town of Davidson, n.d.-e). The presence of Davidson College has also uniquely influenced the development of the town, both as a major employer and as an educational center.

Infrastructure

Major transportation features

Davidson is surrounded by several highway systems, the most notable being I-77 which is a 600 mile system that extends from Ohio to South Carolina. The remaining major highways within the municipality include NC-115 and Davidson-Concord Road. These three highways are critical arteries for commercial and personal traffic. In 2016, I-77 experienced 82,000 traveling vehicles every day, NC-115 experienced 16,000 vehicles daily, and Davidson-Concord Road experienced 11,000 vehicles daily (NC Department of Transportation, 2017).

A Norfolk-Southern Railroad line runs through the town. This rail line, called the O-Line, extends from Mooresville to Charlotte and connects to the L-Line that runs from Mooresville to Winston-Salem. Currently this line generates no activity through Davidson (R. Fitzgerald, personal communication, September 21, 2017).

The Charlotte Area Transit System services commuters from Davidson with the 77x Express bus that provides transportation to and from uptown Charlotte. Commuters from the town also have access to



the North Mecklenburg Village Rider, which connects passengers to Davidson, Huntersville, and Cornelius (Town of Davidson, n.d.-c).

Critical infrastructure

Critical infrastructure serves as the backbone of the municipality's economy, security, and health. Incapacitation or destruction of these critical points could have a debilitating effect (Department of Homeland Security, 2017). The failure of these critical points affects citizens' ability to heat homes, access clean water, and communicate effectively throughout the town. The critical infrastructure in Davidson includes: major IT servers, fiber optic access points, gas transmission pipelines, primary electrical lines and substations, pump stations, and ground and/or elevated water storage tanks.

IT servers

Three major IT servers are located within the town, which the community relies upon for much of its web-based communications. Nucentric Solutions operates two of the servers; one of these is located at the Davidson Town Hall and is used to support local government operations, and the second is located at Nucentric's offices near the downtown area, servicing multiple private-sector clients (Nucentric Solutions, 2017). Davidson College owns the third IT server.

Fiber optic access points

A fiber optic access point is a station that transmits and receives data. The point serves to connect multiple users in a defined network (Rouse, 2010). Davidson has yet to fully convert to fiber Internet access. Currently, residential fiber access is only available to 8% of the community (BroadbandNow, 2017).

Gas transmission pipelines

Five pipelines run through Davidson. Two pipelines are located near West Davidson, specifically west of I-77 passing below Lake Norman. Three pipelines are located east of Davidson College, passing beneath Grey Road, which consists of mostly rural area (National Pipeline Mapping System, 2017).

Primary electrical lines and substations

Davidson has three substations and accompanying primary electrical lines provided by Duke Energy. The largest substation, consisting of ten primary electrical lines, is in the eastern part of the town. The second substation, consisting of three primary electrical lines, is in the southern part of the town, near Cornelius. The third and smallest substation, consisting of one primary electrical line, is located west of the town (Homeland Infrastructure Foundation-Level Data Subcommittee, 2016).

Pump station

The closest water pumping station is an intake located on Lake Norman at Blythe Landing. This intake supplies gravity-fed water to Charlotte's water treatment plant in Huntersville, NC (Sasser, 2016). Sewer lift stations throughout Davidson are maintained by Carolina Lift Stations, which provides emergency and non-emergency repairs, monitors the system for troubleshooting, and maintenance (Carolina Lift Stations, 2017).

Ground and elevated water storage tanks

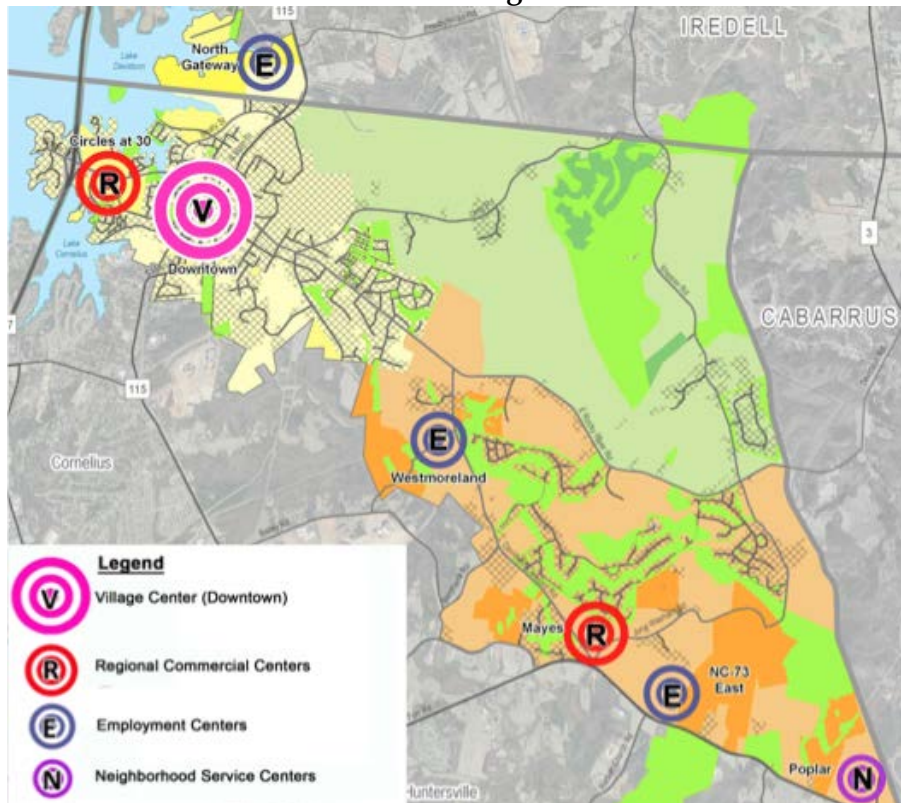
Charlotte Water provides water services to Davidson (Sasser, 2016); as a result, there are no water towers or other large forms of water storage located within the town.



Growth Trends and Land Use

Davidson’s population is expected to increase to 15,000 by 2020 and 21,000 by 2030. If population grows as projected, Davidson will need at least 2,800 additional housing units by 2030, including affordable and senior housing. Additionally, the demand for retail space is projected to increase by 400,000 square feet to 800,000 square feet by 2030 (Woods et al., 2010). To serve both current and future citizens’ best interests, Davidson adopted a Comprehensive Plan in 2010 to map future growth, with a focus on smart growth. This Comprehensive Plan will be updated in 2018 to reflect current trends. Davidson intends for this document to serve as a guide for both the town and its residents, businesses, and community centers, with the areas of focus noted in Figure 2.1. below. The document focuses on eight themes (see Appendix A), each with its own goals, recognition of current initiatives in progress, and targeted growth plans.

Figure 2.1
Areas of Focus for the Targeted Growth Plan



Source: Davidson Comprehensive Plan (2010)

Davidson also adopted a Rural Area Plan in September 2016 to manage the growth and development of the rural area (ETJ) surrounding Davidson called the North Star district. Davidson’s Emergency Services already serve this area for emergency response. A major focus of this plan involves the preservation of green and open space and mixed-use developments that support walkability. The plans also include expansion of public utilities to some of the North Star district as noted in Figure 8.1., located in Appendix A.



Service Demand

Number of Incidents and Incident Types

The National Fire Incident Reporting System (NFIRS) provides standard definitions for incident types. The incident types are organized into nine series; each series has a range of codes that describe the incident more specifically. Emergency personnel record the incident type when they arrive on the scene of a call (USFA, 2015).

Between January 1, 2012 and December 31, 2016, the Davidson Fire Department responded to 6,246 calls—an average of 1,249 calls annually. The top three incident types were *Emergency Medical Service call, excluding vehicle accident with injury* (27%), *Medical Assist, assist EMS crew* (15%), and *Dispatched and cancelled en route* (14%) (Davidson Fire Department Incident Data).

Table 2.2. provides a breakdown of calls by incident series that the Davidson Fire Department responded to between January 1, 2012 and December 31, 2016. The top three incidents series were *Rescue and Emergency Medical Services* (50.2%), *Good Intent Call* (18.3%), and *False Alarm and False Call* (16.8%).

Table 2.2
Davidson Fire Department 2012 – 2016: Incident Series

NFIRS Incidents Type Series Code/Title	Total Incidents
100 – Fires	218 (3.5%)
200 - Overpressure Rupture, Explosion, Overheat (No Fire)	22 (0.4%)
300 - Rescue and Emergency Medical Service Incident	3,133 (50.2%)
400 - Hazardous Condition (No Fire)	213 (3.4%)
500 - Service Call	436 (7.0%)
600 - Good Intent Call	1,145 (18.3%)
700 - False Alarm and False Call	1,052 (16.8%)
800 - Severe Weather and Natural Disaster	8 (0.1%)
900 - Special Incident Type	19 (0.3%)

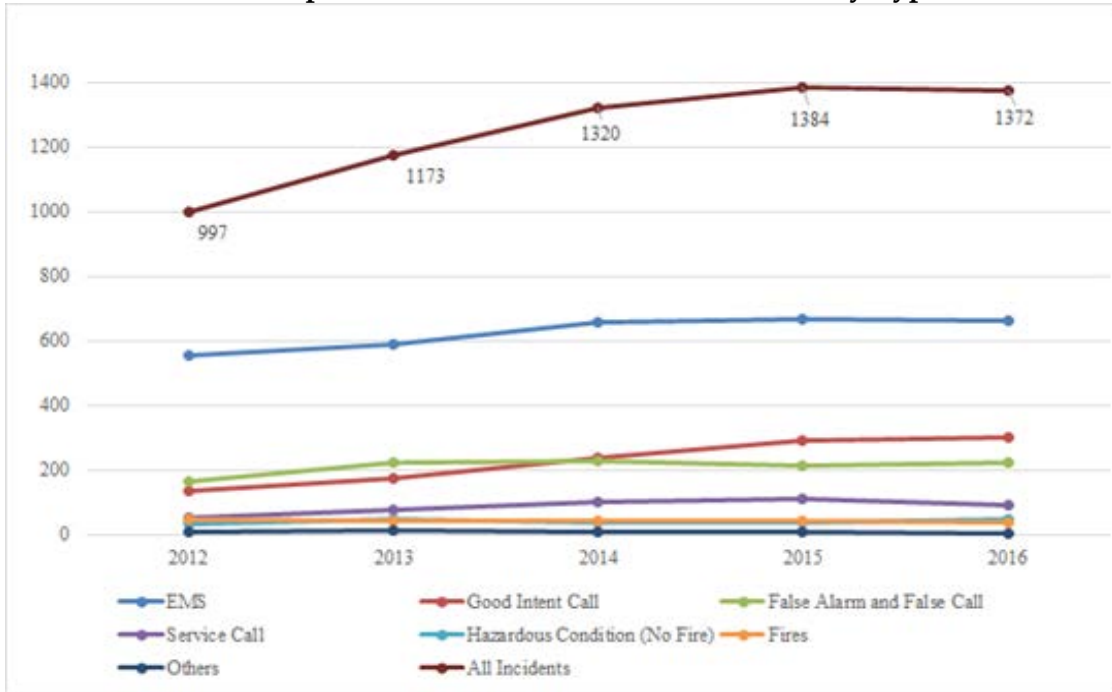
Source: Davidson Fire Department Incident Data

Figure 2.2. represents annual incidents volume by series occurring each year between 2012 - 2016. The data show that the overall number of incidents increased by 38% between 2012 and 2016. Much of the increase is attributed to the *Dispatched and cancelled en route* incident type; (which accounted for 38% of the growth), *Medical assist, assist EMS crew* (23% of the growth), and *Motor vehicle accident with no*



injuries (9% of the growth). Other incident types have remained relatively steady. (Davidson Fire Department Incident Data).

Figure 2.2
Davidson Fire Department 2012 – 2016: Incident Volume by Type and Year



Source: Davidson Fire Department Incident Data

Incident Locations

From January 1, 2012 to December 31, 2016, the Davidson Fire Department responded to 6,246 incident calls in the following zones: 3,305 incidents in Davidson-West (53%), 1,126 incidents in Davidson-East (18%), and 788 incidents in Davidson College (12.6%). The Department also responded to calls in nearby communities as part of a reciprocal agreement that includes Cornelius, Mount Mourne, and Odell. Combined, the Davidson Fire Department responded to 1,027 incidents (16.4%) in these communities. (Davidson Fire Department Incident Data).

Response Times

Based on incident data available, the MPA team calculated response times by subtracting the dispatch times from the arrival times. The Davidson Fire Department’s average response time for all calls between 2012 and 2016 was 5.74 minutes per call. The incident data also revealed that for 25% of incidents, the Davidson Fire Department’s response time was equal to or below 4 minutes; for 50% of total incidents the response time was equal to or less than 5 minutes; and for 75% of incidents the response time was equal to or below 7 minutes.



RISK ASSESSMENT METHODOLOGY

The MPA team used various methods to conduct the hazard analysis and vulnerability assessment. These include:

- Extensive literature review of risk assessments and disaster management best practices
- Interviews with Davidson, Mecklenburg County, and State of North Carolina officials
- Quantitative analysis of incident reporting and GIS mapping of critical locations and incidents
- Qualitative analysis on the Priority Risk Index (PRI)

Literature Review

The MPA team conducted a literature review of disaster management principles to identify the risks explored in this analysis. This literature review included scholarly journals, government reports, and internet resources. Internet resources came from sites maintained by relevant government agencies, professional organizations, and other experts with extensive knowledge of the hazards discussed in this report.

Expert Interviews

The MPA team conducted expert interviews with representatives from regional agencies in Davidson and Mecklenburg County, including the Davidson Police, Fire, and Planning Departments, Charlotte Water, the North Carolina Division of Forest Resources, and Charlotte-Mecklenburg Stormwater Services.

Incident Report Analysis

Incident report data regarding local hazard incidents were acquired from Davidson and other local agencies. The MPA team used these data to identify the history and frequency of local hazard incidents, and to evaluate the threat posed to critical facilities.

PRI Value Assessment

To remain consistent with the hazard mitigation report conducted by Mecklenburg County, the vulnerability assessment relies primarily on qualitative analysis using the PRI scale. The Mecklenburg County Mitigation Planning Committee used the PRI scale to rank and prioritize the likelihood and consequences of natural disasters. The MPA team has expanded the use of the PRI scale to include both natural and manmade hazards.

The PRI values are calculated through a weighted assessment across five categories: *probability*, *impact*, *spatial extent*, *warning time*, and *duration* as described by the following equation:

$$PRI\ Value = [(Probability \times .30) + (Impact \times .30) + (Spatial\ Extent \times .20) + (Warning\ Time \times .10) + (Duration \times .10)]$$



Probability estimates the annual likelihood of a single event of that hazard. *Impact* estimates physical damage to critical facilities, injuries and/or deaths, and economic damage for a particular hazard. *Spatial extent* refers to the proportion of Davidson that could be impacted by a single event. *Warning time* is the amount of time between awareness that an event will occur and that event reaching the town. *Duration* is the length of an event.

The benchmarks for each value are described in Table 3.1. The *degree of risk* is the expected outcome for each category for each hazard.



Table 3.1
Summary of Priority Risk Index

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

Source: Mecklenburg County Mitigation Planning Committee



According to the information collected through the literature review, expert interviews, and incident reports, the MPA team assigned values for each hazard. The PRI scale provides a matrix through which to compare all hazards, regardless of available quantitative data.

The PRI scale was created to evaluate the risk posed by natural disasters. Its primary value is in ranking and prioritizing hazards against each other. There are, however, limitations to measuring risk on a four-tiered value system. In particular, events that have a near-zero likelihood of occurring that could pose considerable threats to the town if they occurred may receive very high rankings, while events that occur regularly but do not threaten severe, widespread, or long-term damage may be ranked lower. Readers should keep these limitations in mind when reviewing the PRI rankings.



RISK IDENTIFICATION AND ANALYSIS

The MPA team's primary task was to identify a list of potential hazards to Davidson and calculate the risk to the town for each potential hazard.

The hazards identified by the team include:

- Nuclear reactor failures
- Winter storms
- Thunderstorms/hailstorms
- Fire
- Hurricanes/tropical storms
- Wildfires
- Tornadoes
- Hazardous materials: Pipeline incident
- Earthquakes
- Dam failures
- Drought/heat
- Hazardous materials: Transportation incidents
- Terrorism and active shooter events
- Flood
- Severe disease outbreak
- Sinkhole
- Landslides

Table 4.1 presents PRI values for each of the hazards discussed, ranked from greatest to least risk. The MPA team assigned values based on historical trends, expert consultation, and professional judgement. While the table is presented in order of greatest to least risk, it is equally important to compare the events across the five categories of the PRI scoring system, which capture the scope and likelihood of each hazard.



**Table 4.1
PRI Values**

Risk	Probability	Impact	Spatial Extent	Warning Time	Duration	PRI Value
Nuclear Reactor Failures	1	4	4	4	4	3.1
Winter Storms	3	3	4	1	3	3.0
Thunderstorms/Hailstorms	4	2	3	4	1	2.9
Fire	4	2	2	4	1	2.7
Hurricanes/Tropical Storms	2	3	4	1	2	2.6
Wildfires	4	1	2	4	2	2.5
Tornadoes	2	3	2	4	1	2.4
Hazardous Material: Pipeline Incident	1	3	2	4	2	2.2
Earthquakes	1	1	4	4	1	2.2
Dam Failures	1	3	2	2	3	2.1
Drought	2	2	2	1	4	2.1
Hazardous Material: Transportation Incident	1	3	2	4	1	2.1
Terrorism & Active Shooter Events	1	3	2	4	1	2.1
Severe Disease Outbreak	1	2	1	4	4	1.9
Flood	2	1	2	3	2	1.8
Sinkholes	1	2	1	4	1	1.6
Landslides	1	1	1	2	1	1.1

The remainder of this section discusses these hazards in more detail. Each subsection below defines the relevant hazard and presents the scoring rationale for the five categories of the PRI scale. The hazards are presented in order from highest (greatest risk) to lowest (least risk) overall PRI value, as listed in Table 4.1.



Nuclear Reactor Failures

McGuire Nuclear Station lies approximately 6.5 miles outside of Davidson. It is owned and operated by Duke Energy and has two pressurized water reactors that produce electricity. Nuclear reactor failure can occur for a variety of reasons ranging from natural disasters to simple worker error or sabotage. Two scales can be used to define nuclear reactor failure and its effects: The International Nuclear and Radiological Event Scale (INES), created by the International Atomic Energy Agency (IAEA), and the U.S. Nuclear Regulatory Commission (NRC) Emergency Classifications.

INES uses a numerical rating to explain the significance of events associated with sources of ionizing radiation. Events are rated at seven levels: level one is rated an *anomaly*, levels two and three are rated *incidents*, and levels four through seven are rated as *accidents*. INES also records events that are considered “below scale/level zero” and rates them as having no safety significance. These levels consider three areas of impact: people and the environment, radiological barriers and control, and defense in depth (referring to the existence of multiple layers of security controls). The Chernobyl accident is an example of a level seven INES event (IAEA, 2016). For a more detailed look at the INES scale, see Table 8.3. located in Appendix C.

The NRC employs four emergency classifications: notification of an unusual event, alert, site area emergency, and general emergency. The most serious classification is a general emergency in which there is “imminent substantial core degradation or melting with potential for loss of containment integrity or hostile action that results in an actual loss of physical control of the facility” (NRC, 2014c). For a more detailed look at the NRC classifications, see Table 8.4. located in Appendix D.

The overall PRI value for nuclear reactor failure is 3.1. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

There have been zero recorded nuclear reactor events at McGuire Nuclear Station. Additionally, the IAEA has only recorded six nuclear reactor events in the entire United States since 1952. Of these six events, all but the Three Mile Island accident was considered

PRI SCORE

3.1



PROBABILITY

Unlikely 1

IMPACT

Catastrophic 4

SPATIAL EXTENT

Large 4

WARNING TIME

< 6 hours 4

DURATION

> 1 week 4



“below scale/level zero”. Given the very low incidence rate, the MPA team assigned probability a PRI value of 1.

Impact

The most dangerous nuclear reactor event to date was the Chernobyl accident. The accident occurred in Soviet Russia in 1986 when a sudden surge of power destroyed Unit 4 of the nuclear power station, releasing large amounts of radioactive material into the environment. This accident killed 28 of the site’s workers and caused an estimated 6,000 cases of thyroid cancer among children living in the area (American Nuclear Society, 2012). Additionally, approximately 200,000 clean-up workers were found to have been exposed to elevated levels of radiation (NRC, 2014a). Depending on the severity of the radiation exposure, those exposed could face death, acute radiation syndrome, cutaneous radiation injury, cancer, and mental health risks (Centers for Disease Control and Prevention, 2014).

According to the NRC, the safety protocols and procedures in the United States, including ensuring the availability of backup systems to deal with potential accidents, make failure similar to the Chernobyl accident highly unlikely in this country. However, while highly improbable, reactor failures are still possible. Should failure occur, the potential impacts could be catastrophic to both citizens and the environment. As a result, the MPA team assigned a PRI value of 4 for the potential impact of a nuclear reactor failure at McGuire Nuclear Station.

Spatial Extent

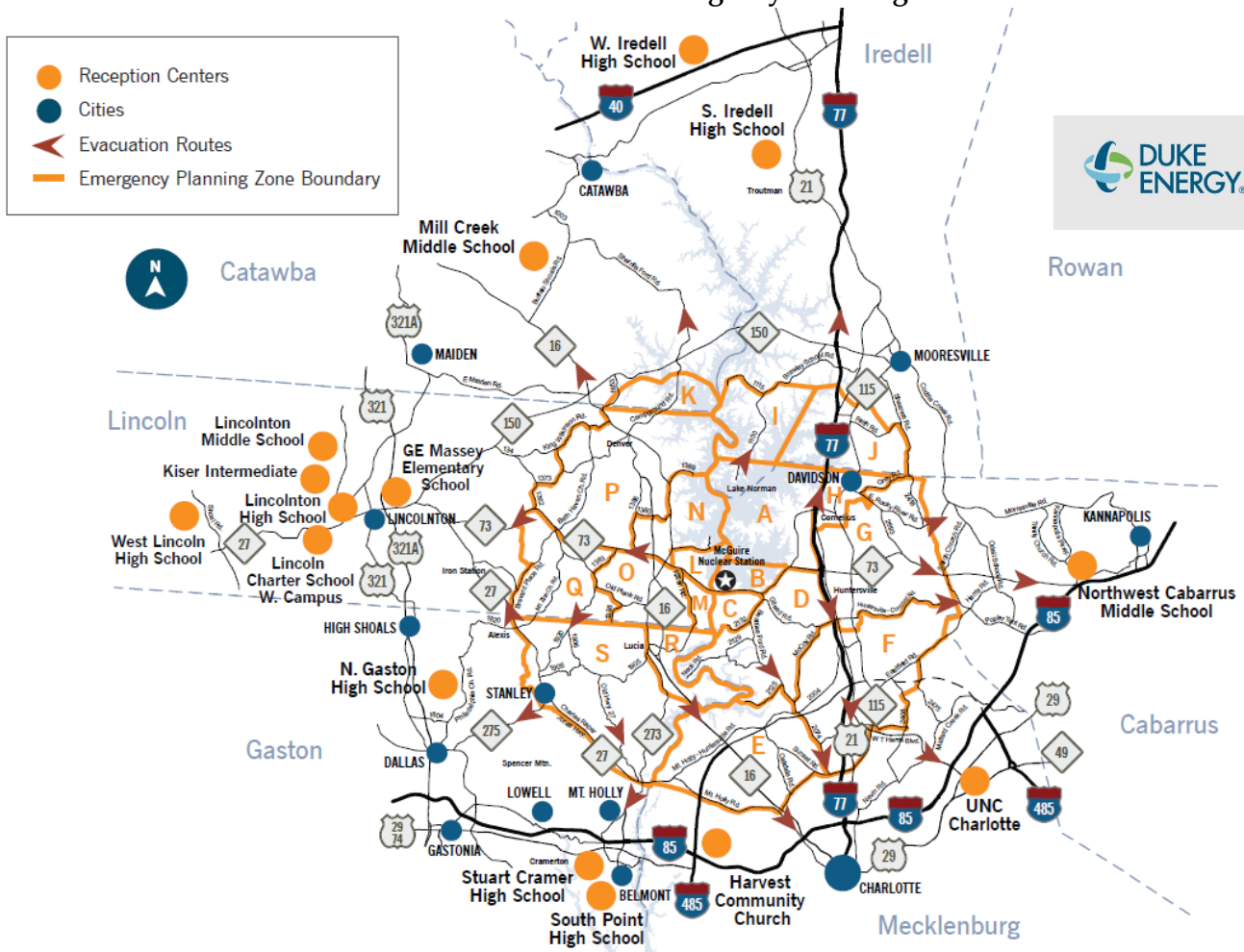
The NRC employs two emergency planning zones around each nuclear power plant, including the plume exposure and ingestion exposure zones. The plume exposure zone, also known as the emergency planning zone, has a radius of 10 miles and is concerned with exposure to and inhalation of airborne radioactive contamination. The ingestion exposure zone has a radius of 50 miles and is primarily concerned with the ingestion of food and liquid that may have become contaminated (NRC, 2014d). Should radiation escape a nuclear facility, the NRC typically recommends evacuation of residents in the plume exposure zone; however, evacuation authority is granted only to state and local officials (NRC, 2017). Coordination of an evacuation in Davidson would be facilitated by state and local officials in conjunction with Duke Energy (NRC, 2014e). Figure 4.1. provides the emergency evacuation plan created by Duke Energy for Mecklenburg County.



Source: Duke Energy



Figure 4.1
McGuire Nuclear Station Emergency Planning Zones



Source: Duke Energy

As displayed in Figure 4.1., Davidson lies within the emergency planning zone (i.e. the plume exposure zone). If an event classified as general emergency and scoring five or higher on the INES scale occurs, the entire town would be affected. Therefore, for the spatial extent of nuclear reactor failure, the MPA team assigned a PRI value of 4.

Warning Time

As nuclear reactor failure is a truly random event, there is likely to be little to no warning time. The 2011 Fukushima nuclear reactor and the 1979 Three Mile Island accident provide examples of nuclear reactor failure for which no warning time could be provided (NRC, 2017). In both events, the nuclear reactor failure resulted in potential release of radioactive material within hours of reactor failure (NRC, 2017). Given the lack of notice for a nuclear reactor failure event, the MPA team assigned warning time a PRI value of 4.



Duration

Consistent with similar historical occurrences, cleanup efforts proceeding a nuclear reactor failure event at McGuire Nuclear Station could last for years. For example, cleanup of the Three Mile Island accident began in July 1980 and did not officially end until December 1993 (NRC, 2014b). Additionally, cleanup of the Fukushima nuclear accident (which occurred in March 2011) is still ongoing (NRC, 2017). Because of the extended nature of cleanup procedures, the MPA team assigned duration a PRI value of 4.



Winter Storms

According to the National Weather Service (NWS), winter storms that develop within the state of North Carolina have at least one of the following events occur within a 24 hour period (N. Petro, personal communication, October 10, 2017):

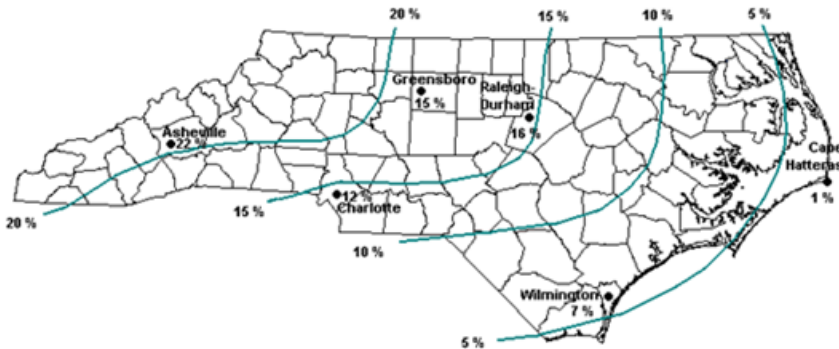
- Snow accumulation of more than 3 inches,
- Ice accumulation from freezing rain or freezing drizzle of more than ¼ inch, or
- Sleet accumulation of more than ½ inch.

The overall PRI value for winter storms is 3.0. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

The NWS estimates that Davidson has at least a 10% chance of receiving heavy snowfall (8 inches or more) in any given winter period (Badgett, Baines, Blaes, Hartfield, & Keeter, n.d.); this is illustrated in Figure 4.2., which provides the probability of heavy snowfall for each area within North Carolina.

**Figure 4.2
Probability of Heavy Snowfall (8 inches or more)**



Source: National Weather Services.

Between January 1, 2002 and June 1, 2017, the Concord weather station (located approximately 15 miles southeast of Davidson) experienced an average of two winter storms per year (Climate Office of North Carolina, 2017). Details regarding these storms are provided in Table 8.5., located in Appendix E. Considering the station’s proximity to Davidson and that winter storms can occur over vast areas, it is likely that Davidson will experience similar

PRI
SCORE

3.0



PROBABILITY

Likely	3
--------	---

IMPACT

Critical	3
----------	---

SPATIAL EXTENT

Large	4
-------	---

WARNING TIME

> 24 hours	1
------------	---

DURATION

< 1 week	3
----------	---



winter storm-related precipitation on an annual basis. Therefore, the MPA team assigned probability a PRI value of 3.

Impact

The impacts of winter storms vary, but may include property damage, fallen trees, and injuries or fatalities; however, power outages are a primary concern. Widespread power outages can interrupt operations for businesses, schools, and other public institutions. Winter storms can also disrupt traffic and increase the potential for traffic accidents, a leading cause of fatalities during winter storms.

Winter storms are often more disruptive in the southern part of the United States because this region is less likely to have the equipment and resources needed to handle the impacts of frequent and heavy snowfalls

(Changnon, Changnon, & Karl, 2006). The National Climatic Data Center (NCDC) reported that over the past 15 years, winter storm-related impacts have caused approximately \$43 million in property damage in Mecklenburg County. Considering these factors, the MPA team assigned impact a PRI value of 3.



Source: Town of Davidson

Spatial Extent

National historical data suggests that catastrophic winter storms can stretch across multiple states (Changnon, 2007). Davidson is a relatively small town by geographical area, making the entire town vulnerable to a winter storm event. Thus, the MPA team determined that the PRI value for spatial extent is a 4.

Warning Time

The NWS issues winter storm warnings 24 to 28 hours in advance (J. Blades, personal communication November 3, 2017). Therefore, the MPA team assigned warning time a PRI value of 1.

Duration

The longest and most severe winter storm in Mecklenburg County within the last 21 years lasted less than one week. Based on this, the MPA team assigned duration a PRI value of 3.



Thunderstorms/ Hailstorms

The National Weather Service (NWS) defines a thunderstorm as a “local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder²” (NWS, 2009a). On occasion, severe thunderstorms may also result in hailstorms, where pellets or balls of ice larger than 5 mm in diameter fall in showers from cumulonimbus clouds (NWS, 2009b).

Three conditions are generally required to form a thunderstorm: moisture, an unstable air mass, and heat. Because of this, thunderstorms are most common in central and southern states, where atmospheric conditions are ideal for these storms to develop.

The overall PRI value for thunderstorms/hailstorms is 2.9. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

On average, the Davidson area experiences thunderstorm activity 40 to 50 days per year (State Climate Office of North Carolina, n.d.). Hailstorms occur less than 2 days per year (AECOM, 2015). According to the National Assessment Synthesis Team (NAST) report of 2001, climate is warming at a rapid rate which “will very likely be associated with extreme precipitation and faster evaporation of water, leading to greater frequency of both very wet and very dry conditions” (NAST, page 6, 2001). These findings suggest that severe thunderstorms will continue to occur, especially in southern states, with 100% annual probability. Taking all of this into consideration, the MPA team assigned probability a PRI value of 4.

Impact

Thunderstorms can produce lightning, damaging winds, flooding, and hail. These dangers may result in property damage to buildings, vehicles, powerlines, and vegetation. Additionally, thunderstorms can be life-threatening, causing an average of 2,000 injuries and 156 deaths per year in the United States (McNeill, n.d.). In North Carolina, summer thunderstorms, including hail storms, cause an estimated \$5 million in damages annually (State Climate Office of North Carolina, n.d.).

PRI SCORE

2.9



PROBABILITY

Highly likely	4
---------------	---

IMPACT

Limited	2
---------	---

SPATIAL EXTENT

Moderate	3
----------	---

WARNING TIME

< 6 hours	4
-----------	---

DURATION

< 6 hours	1
-----------	---



Since 1950, Mecklenburg County has experienced 244 severe thunderstorms and 160 hailstorms. Combined, these storms caused 7 deaths, 20 injuries, and an estimated \$4.9 million in property damage. (AECOM, 2015). This indicates that while deaths, injuries, and property damage do occur, they are not associated with every severe thunderstorm or hailstorm. Considering all this information, the MPA team assigned a PRI value of 2 for the impact of thunderstorms and hailstorms.

Spatial Extent

The average thunderstorm is 15 miles in diameter (National Disaster Education Coalition, 1999). Hailstorms frequently accompany thunderstorms, meaning their locations and spatial extents coincide. Given the fact that Davidson encompasses an area of 13.22 square miles, including the ETJ, a thunderstorm would likely affect most of Davidson. Therefore, the MPA team assigned spatial extent a PRI value of 3.

Warning Time

The NWS issues severe thunderstorm warnings approximately 19 to 22 minutes in advance of the storms (J. Blades, personal communication November 3, 2017). Given this, the MPA team assigned warning time a PRI value of 4.

Duration

A typical thunderstorm stays over an area for 20 to 30 minutes. (National Disaster Education Coalition, 1999). Based on this information, the MPA team assigned duration a PRI value of 1.



Structure and Vehicle Fire

A structure fire is any fire originating in a building, shelter, or other structure (National Park Service, 2003). For firefighting purposes, the National Fire Protection Association (NFPA) has divided structures into five types. The types range from Type I to Type V, with Type I being the least combustible and Type V being the most combustible. An example of a Type I structure is a high-rise constructed of steel and concrete, while an example of a Type V structure is a modern home constructed mostly of wood (Frassetto, 2012). The NFPA lists the leading causes of structure fires as cooking equipment, electrical distribution, lighting equipment, and heating equipment.

A vehicle fire is a type of fire involving mobile property such as cars, trucks, and mass-transit vehicles, or their fuel and cargo. Vehicle fires have unique risks due to their potential to produce explosions, toxic smoke, and runoff (Carmel Fire Department, n.d.). Vehicle fires are generally attributed to mechanical and electrical malfunctions, vandalism, collisions, and exposure from other fires (Ahrens, 2010).

The overall PRI value for structure and vehicle fire is 2.7. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

The Davidson Fire Department responds to an average of 29 structure fires and approximately 5 vehicle fires annually. Table 8.6., located in Appendix G, displays a breakdown of the number of fire incidents in Davidson by year. Because fires are a common occurrence in Davidson, the MPA team assigned probability a PRI value of 4.

Impact

Impacts of structure and vehicle fires can range depending on the severity of the fire. Impacts may include minor property damage and small injuries, such as first degree burns and respiratory illnesses. However, a major structure fire could result in large impacts, such as fatalities, serious injuries, and a total loss of infrastructure. Major structure fires may necessitate an extensive cleanup and restoration

PRI SCORE

2.7



PROBABILITY

Highly likely	4
---------------	---

IMPACT

Limited	2
---------	---

SPATIAL EXTENT

Small	2
-------	---

WARNING TIME

< 6 hours	4
-----------	---

DURATION

< 6 hours	1
-----------	---



process, which can cost a municipality or individual thousands of dollars (Homeadvisor, 2017).

Davidson Fire Department responds to an average of 50 fire related calls annually. The majority of these fires are contained to their point of origin and do not result in significant injury or property damage. Considering the historical incidence for Davidson and the likely impacts, the MPA team assigned structure and vehicle fire a PRI value of 2. However, if Davidson were to have a major structure fire, the town could experience more severe impacts.

Spatial Extent

Fires can spread easily and quickly for a variety of reasons. A fire could remain undetected and spread to additional areas or buildings; also, a failure in communication could result in delayed notification to a fire department. In addition, the current weather conditions and the type of materials involved in the fire can both contribute to the rate at which the fire spreads. The Topical Fire Research Series (TFRS) claims that structure fires spread to other structures 70% of the time, to vehicles 22% of the time, and to outside areas 3% of the time. Additionally, vehicle fires spread to structures 25% of the time, to other vehicles 68% of the time, and to outside areas 5% of the time (U.S. Fire Administration, 2007).



Source: Lake Norman Citizen

While fires have the potential to spread and affect multiple structures, modern technologies like sprinkler systems, water mist systems, fire suppression systems, aided by rapid responses from the Davidson Fire Department mean that the overall destruction of a structure or vehicle fire would likely be limited to a confined area. Considering this, the MPA team assigned spatial extent a PRI value of 2.

Warning Time

Because a small open flame or spark can escalate into a raging fire within minutes, structure and vehicle fires occur quickly with no warning (Department of Homeland Security, n.d.). Considering this, the MPA team assigned warning time as a PRI value of 4.

Duration

Historical incidence indicates that the structure and vehicle fires in Davidson are typically contained in less than six hours after firefighters reach the scene of the fire. While a large-scale structure fire could last in excess of six hours, there have been no instances of such fires in Davidson. Considering this, the MPA team assigned duration a PRI value of 1.



Hurricanes/Tropical Storms

Hurricanes and tropical storms form over ocean waters when water and atmospheric temperatures are warm (Weather Questions, 2013). Hurricanes have sustained wind speeds in excess of 74 miles per hour, and wind speeds for tropical storms range from 39 to 74 miles per hour. (National Oceanic Atmospheric Administration, 2017).

The overall PRI value for hurricane and tropical storm is 2.4. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

Hurricane season in the U.S. runs from June through November and results in an average of 10.1 named storms per year; on average, 5.9 of those become hurricanes. Because most hurricanes form in the Atlantic Ocean, Caribbean Sea, or Gulf of Mexico, they primarily hit land in the southeastern to eastern states. Eighty-eight percent of major hurricanes hit either Florida or Texas (National Oceanic Atmospheric Administration, 2016).

Hurricanes are considered “direct hits” when they touch the coast. Between 1851 and 2015, 50 hurricanes have directly hit North Carolina—with 13 considered major hurricanes. Almost half of the direct hits were Category 1 hurricanes (National Oceanic Atmospheric Administration, 2016). North Carolina also experiences an average of 1.74 “indirect hits” each year. While these hurricanes do not touch the North Carolina coast, they still impact the state’s climate, causing high winds, floods, and storms that negatively affect residents.

There have been seven hurricane or tropical storm tracks within 75 miles of Mecklenburg County since 1950. (National Hurricane Center, n.d.). Considering this, the MPA assigned probability a PRI value of 2.

Impact

Hurricanes and tropical storms vary in strength and potential impacts. The Saffir-Simpson hurricane scale provided in Table 4.2. shows the different hurricane categories and the associated level of damage (National Oceanic Atmospheric Administration, n.d.-b).

PRI SCORE

2.6



PROBABILITY

Possible	2
----------	---

IMPACT

Critical	3
----------	---

SPATIAL EXTENT

Large	4
-------	---

WARNING TIME

> 24 hours	1
------------	---

DURATION

< 24 hours	2
------------	---



Table 4.2
Saffir-Simpson Hurricane Scale

Storm Category	Wind speed (mph)	Damage Level	Description of Damages
1	74-95	Minimal	Produces some damage; damage to roof shingles; damage to vinyl siding and gutters; large branches of trees snap; shallow rooted trees uprooted; damage to power lines and poles
2	96-110	Moderate	Well-constructed homes could have major roof and siding damage; near total power loss; most shallow rooted trees toppled
3	111-129	Extensive	Well-constructed homes could have severe damage; many trees snapped and uprooted; water and power will be unavailable for several days and possibly weeks
4	130-156	Extreme	Well-constructed homes have severe damage to roof, interior and exterior walls; most trees snapped and power lines down; power outages for weeks possibly months; uninhabitable for weeks to months
5	157+	Catastrophic	High percentage of framed homes will be destroyed; total roof failure and wall collapse; fallen trees and power poles; power outages for months; most areas will be uninhabitable for months

Source: National Hurricane Center

Of the seven hurricanes or tropical storm tracks within 75 miles of Mecklenburg County, Hurricane Hugo was the only Category 2 hurricane. In 1989, Hurricane Hugo made landfall in South Carolina as a Category 4, and had turned into a Category 2 with winds reaching 100 miles per hour by the time it reached Mecklenburg County. After Hurricane Hugo, 85% of homes and businesses in Charlotte were reportedly without power. Additionally, three fatalities in Charlotte were associated with the storm (Armstrong, 2014).

Events like Hurricane Hugo are rare. Davidson is located far enough inland that any hurricane would slow down significantly before reaching the town. Since 1950, six of the seven storm tracks within 75 miles of Mecklenburg were tropical storms with wind speeds less than 70 miles per hour (National Hurricane Center, n.d.). However, if a hurricane hit Davidson directly, damage could be extensive. Therefore, the MPA team assigned impact a PRI value of 3.



Spatial Extent

Hurricanes affect a large area, even at the lowest category on the Saffir-Simpson wind scale. An average sized hurricane is 100 miles in diameter, while an average size tropical storm is between 200 and 400 miles in diameter (Weather Research Center, n.d.). Given the size of Davidson, the entire town would feel the effects of a storm. Considering this, the MPA team assigned a PRI value of 4.

Warning Time

Official hurricane and tropical storm *watches* are communicated an average of 48 hours before a storm makes landfall. Hurricane and tropical storm *warnings* are generally communicated an average of 36 hours before the storm makes landfall (National Oceanic Atmospheric Administration, n.d.-a). Therefore, the MPA team determined the warning time to be more than 24 hours, assigning a PRI value of 1.



Source: Mooresville Tribune

Duration

Hurricanes and tropical storms travel at different speeds depending on the category and strength of the storm. While the effects of a direct hit to Davidson could be felt for weeks, the storm itself would likely take less than 24 hours to pass through the town. Given this information, the MPA team assigned a PRI value of 2 for the duration of hurricanes.



Wildfires

A wildfire is any non-structure fire that occurs in the wildland. These fires are typically categorized as grass, brush, natural vegetation, woods, wild land, or forest fires (U.S. Forest Service, n.d.). Humans cause 90% of wildland fires in the United States through unattended campfires, burning debris, cigarettes, or other man-made incendiary causes. Natural causes such as lightning are responsible for the remaining 10%. A hotter, drier climate, and drought are several of the most frequently cited risk factors for wildfires (National Park Service, n.d.).

The overall PRI value for wildfires is 2.5. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

Wildfires tend to be more severe in the Western United States due to its hotter, drier climate and higher prevalence of droughts (The White House Office of the Press Secretary, 2016). Federal and state agencies are typically involved in responding to large wildfires. However, 57% of total brush, grass, and forest fires handled by local fire departments were located in the South (Ahrens, 2013). Historical incidence indicates that Davidson experiences wildfires on a yearly basis. The North Carolina Forest Service responded to seven wildfires in Davidson between 2007 and 2017. All seven fires were small, easily contained, and caused no significant property damage or injury (J. Marlowe, personal communication, September 25, 2017). Additionally, the Davidson Fire Department responded to 70 natural vegetation fires between 2009 and 2017 (Davidson Incident Data, 2017). Of these, 55 were located within Davidson or the ETJ; the other 15 were responses to natural vegetation fire in mutual aid jurisdictions. Considering the historical incidence, the MPA team gave wildfires a PRI value of 4 for probability.

Impact

Severe wildfires can damage and destroy watersheds, forests, scenic vistas, community infrastructure, and cultural and economic resources. In an area heavily affected by wildfires, there can be an increased potential for flooding, landslides, and debris flow due to a changed topography. Property damage is one of the most frequent

PRI SCORE

2.5



PROBABILITY

Highly likely	4
---------------	---

IMPACT

Minor	1
-------	---

SPATIAL EXTENT

Small	2
-------	---

WARNING TIME

< 6 hours	4
-----------	---

DURATION

< 24 hours	2
------------	---



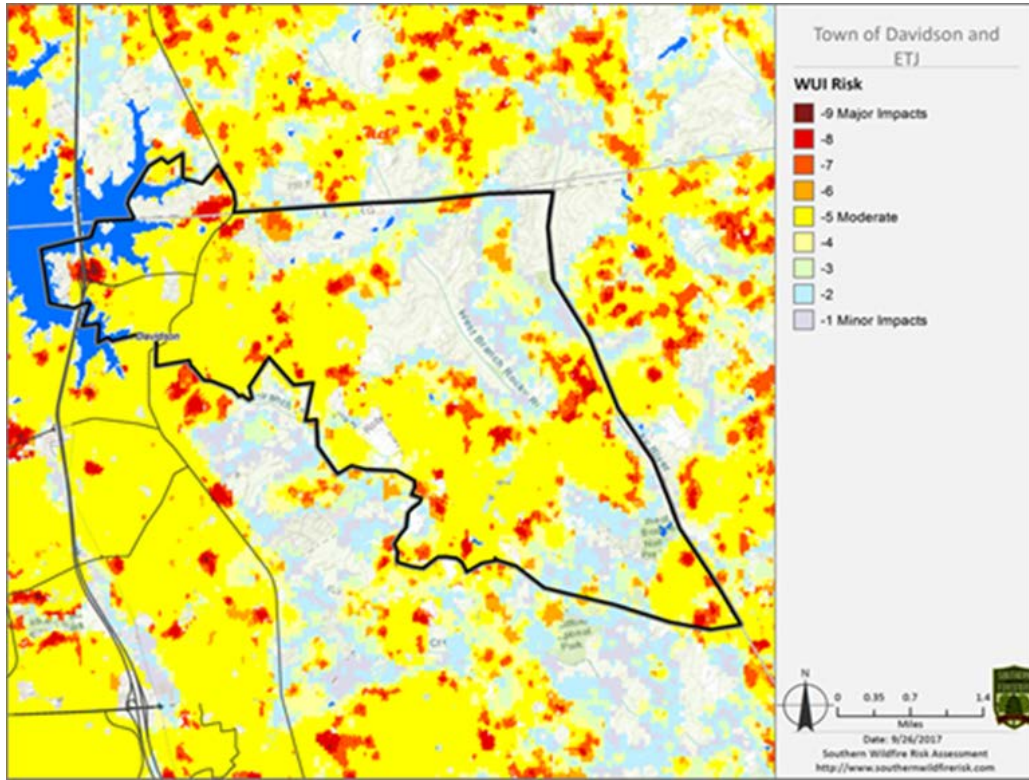
consequences of wildfires, and in severe cases, wildfires can cause injury or death (U.S. Geological Survey, 2006).

Firefighting professionals created the term 'Wildland Urban Interface' (WUI) to refer to an area where structures and other human development meet or intermingle with undeveloped wildland, forest or vegetative fuels. North Carolina has more WUI acres than any other state in the country (North Carolina Forest Service, 2017). On a national level, 60% of homes built since 1990 have been built in the wildland-urban interface (The Office of the Press Secretary, 2016). The Southern Wildfire Risk Assessment estimates that around 90% of Davidson's population lives within the WUI. The growth of populations residing in the WUI increases the potential for wildfires to threaten public safety (Southern Group of State Foresters, 2017).

Historical incidence in Davidson indicates that wildfires have been minor, with no injuries or significant property damage. According to a representative from the National Carolina Division of Forest Resources (NCDFR), wildfires have 'threatened' structures but not caused any damage between 2007 and 2017 (J. Marlowe, personal communication, September 25, 2017). Considering this, the MPA team assigned the impact of wildfire a 1 on the PRI scale. Although Davidson does not have a history of severe wildfires, it is possible for a future wildfire occurrence to cause more serious impacts for the town depending on the location of the wildfire. Figure 4.3. indicates the potential severity of impact that a wildfire could have on people and their homes, should a significant wildfire occur in that area. The map rates an area as having 'major impacts' if the area contains a combination of high housing density and high flame lengths, and 'minor impacts' if the area contains a combination of low housing density and low flame lengths. Flame length is determined by the type of vegetation that is located in that area. Areas deemed as 'major impact' areas have a higher likelihood of experiencing major negative impacts from wildfires such as structure loss, injury, or death (Southern Group of State Foresters, 2017).



Figure 4.3
Wildland Urban Interface Risk Index



Source: Southern Group of State Foresters Wildfire Risk Assessment

Spatial Extent

According to the National Fire Protection Association (NFPA), 76% of the brush, grass, and forest fires handled by local fire departments burnt less than one acre, and only 4% burnt more than ten acres between 2007 and 2011 (Ahrens, 2013). The typical wildfire in Davidson affects less than one acre; considering this, the MPA team gave wildfires a PRI value of 2 for spatial extent.

Warning Time

Wildfires begin spontaneously when human-related or natural ignitions combine with natural vegetation, and can spread rapidly depending on the type of vegetation. Given this, the PRI value for warning time is a 4.

Duration

Wildfires in Davidson are typically contained in less than 24 hours (J. Marlowe, personal communication, September 25, 2017). Considering this information, the MPA team assigned the duration of wildfires a 2 on the PRI scale. While this is the likely scenario for Davidson, it may take several days to contain a severe, uncontrolled wildfire in the unlikely event that one should break out in the town.



Tornadoes

A tornado is a spinning column of air that touches the ground with winds of at least 65 miles per hour (Tornado Facts, 2017). Tornadoes most often coincide with severe thunderstorms, although sometimes they are caused by hurricanes and tropical storms (Edwards, 2017).

Little is known about what causes tornadoes. One theory is that warm moist air rises and meets cool dry air, creating a strong updraft (National Oceanic Atmospheric Administration, 2013). As the parcel of warm moist air rises, it changes altitude and encounters wind from different directions. If the warm moist air encounters the different air directions at the right time and altitude, it can strengthen and create a wind tunnel (National Oceanic Atmospheric Administration, 2013).

Scientists use six classes to categorize tornadoes in terms of severity, with EF-0 being the weakest, and EF-5 being the strongest. Table 4.3 located in the *impact* section below, offers a further description of each category.

The overall PRI value for tornado is 2.4. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

North Carolina has an average of 29.1 tornadoes per year (Livingston, 2016). North Carolina has also experienced two major tornado outbreaks, where multiple tornadoes touched ground in a short time period. On March 28, 1984, North Carolina experienced seven tornadoes causing 42 fatalities. On April 16, 2011, North Carolina experienced 31 tornadoes in one day, resulting in 24 fatalities, 440 injuries, and an estimated \$400 million in property damage (Simmons & Sutter, 2012).

Two recorded tornadoes have touched down in Davidson or the immediate surrounding area (Tornado History Project, 2017). Both tornadoes were rated as category EF-0 and caused little to no damage. Mecklenburg County has experienced 25 tornadoes, all of which were Category EF-3 or lower, and Iredell County has experienced 16 tornadoes, all of which were Category EF-2 or lower. As a result, the MPA team assigned probability a PRI value of 2.

PRI SCORE

2.4



PROBABILITY

Possible	2
----------	---

IMPACT

Critical	3
----------	---

SPATIAL EXTENT

Small	2
-------	---

WARNING TIME

< 6 hours	4
-----------	---

DURATION

< 6 hours	1
-----------	---



Impact

Some tornadoes cause little to no damage while others can devastate a community for months. Potential impacts include injuries, fatalities, and partial or total destruction of infrastructure (National Severe Storms Library, n.d.). The Enhanced Fujita Scale (Table 4.3) categorizes tornados by different levels of severity and their associated damages (Tornado Facts, 2017). This scale uses six different categories, with EF-0 being the weakest and EF-5 being the strongest.

While Davidson has not experienced a tornado higher than EF-0, the strongest tornado recorded in Mecklenburg County was an EF-3. As defined by the Enhanced Fujita Scale, damages associated with this strength include roofs completely torn off along with some walls; most trees uprooted; trains overturned; and vehicles lifted off the ground. A tornado of this strength could cause significant damage to Davidson’s infrastructure and could be life-threatening to its residents. Considering this, the MPA team assigned impact a PRI value of 3.

Table 4.3
Enhanced Fujita Scale

Storm Category	Damage Level	Wind speed (mph)	Description of Damages
EF-0	Gale	65-85	Broken branches; chimney damage; shallow rooted trees pushed over
EF-1	Weak	86-110	Mobile homes pushed off foundation; damage to roofs; moving vehicles pushed off the road
EF-2	Strong	111-135	Frame houses have roof torn off; mobile homes completely destroyed; large trees uprooted; small debris turned into missiles
EF-3	Severe	136-165	Roofs completely torn off along with some walls; most trees uprooted; trains overturned; vehicles lifted off ground
EF-4	Devastating	166-200	Well-constructed houses are destroyed; structures with weak foundations blown away; vehicles could be thrown; large debris turned into missiles
EF-5	Incredible	200+	Most structures severely damaged or destroyed; vehicles become missiles

Source: Tornado Facts



Spatial Extent

The largest recorded tornado was 2.6 miles wide. If such a tornado occurred, it would affect a large portion of Davidson. However, most tornadoes have an average width of just 300 to 500 yards. Given Davidson's history of weak tornadoes, this is the most likely scenario. Considering this, the MPA team assigned spatial extent a PRI value of 2.

Warning Time

Due to the spontaneity with which a tornado might form, warning time is very limited. Meteorologists have found characteristics that help predict when a tornado might form, but there is currently no way to know precisely when or where one will strike. Thus, the MPA team assigned warning time a PRI value of 4.

Duration

The longest recorded time a tornado remained on the ground was 3.5 hours (Hyde, 2014). However, the average tornado remains on the ground for only five minutes (National Severe Storms Library, n.d.). Therefore, the MPA team assigned a PRI value of 1 for duration.



Hazardous Material: Pipeline Incidents

A hazardous material is as a biological, chemical, radiological, or physical substance that could present a danger to human and animal health, or the environment (Institute of Hazardous Materials Management, n.d.). Liquid gasoline and natural gas are examples of elements classified as hazardous materials by the Pipeline and Hazardous Materials Safety Administration (PHMSA) (*Table of Hazardous Materials and Special Provisions*, 2016). Because pipelines in Davidson and the ETJ transport both liquid gasoline and natural gas, the town could be affected by an incident involving a pipeline. A pipeline accident is any “unplanned occurrence that results in a release of oil or natural gas from [a] pipeline” (PHMSA, 2014a).

According to the PHMSA (2014b), pipeline incidents may occur due to:

- Corrosion (external and internal)
- Natural force damage (due to temperature, heavy rains/floods, high winds, earth movement, etc.)
- Excavation damage (by the operator, the operator’s contractor, or a third party)
- Pipe, weld, or joint failure
- Equipment failure
- Incorrect operation

The overall PRI value for a pipeline incident involving hazardous materials is 2.2. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

Significant pipeline incidents occur infrequently. The PHMSA (2017b) defines a significant incident as one in which any of the following conditions are present:

1. Fatality or injury requiring in-patient hospitalization
2. Property damage of \$50,000 or more (including loss to the operator and others), measured in 1984 dollars
3. Highly volatile liquid releases of 5 barrels or more or other liquid releases of 50 barrels or more
4. Liquid releases resulting in an unintentional fire or explosion

PRI SCORE

2.2



PROBABILITY

Unlikely	1
----------	---

IMPACT

Critical	3
----------	---

SPATIAL EXTENT

Small	2
-------	---

WARNING TIME

< 6 hours	4
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DURATION

< 24 hours	2
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According to incident reports filed with the PHMSA (2017b), between 2007 and 2016 the United States experienced 2,867 significant pipeline incidents. Of these reported incidents, 18 occurred in North Carolina with at least one significant event reported every year except for 2009 and 2012. Since 2007, there have been three reported significant incidents in Mecklenburg County, detailed in Table 4.4.

Table 4.4
Significant pipeline events in Mecklenburg County, 2007-2017

Date	Cause	Operator Name	System Type	Fatalities	Injuries	Total cost current year	Barrels spilled
1/21/2007	Corrosion	Colonial Pipeline Co.	Hazardous Liquid	0	0	\$106,222	21
7/17/2007	Excavation Damage	Public Service Co. of NC	Gas Distribution	0	0	\$402,591	0
3/23/2011	Non-Threaded Connection Failure	Colonial Pipeline Co.	Hazardous Liquid	0	0	\$1,339	0

Source: Dawn Blobaum, Assistant Town Manager, Town of Davidson

Because significant pipeline incidents do not historically impact North Carolina or Mecklenburg County, the MPA team assigned probability a PRI score of 1.

Impact

Piedmont Natural Gas Co., Williams, and Colonial Pipeline Co. operate pipelines within Davidson and its ETJ that transport hazardous materials. According to safety data sheets compiled by each company (Colonial Pipeline Company, n.d.; Piedmont Natural Gas Company, Inc., 2016; Williams, Inc., 2017), natural gas and gasoline are highly flammable substances. Because they present an extreme flammability risk, the release of either hazardous material could result in a large fire or explosion. In addition, natural gas and liquid gasoline may pose a risk to the health of humans or animals that are exposed to the hazardous materials for extended periods of time. Safety data sheets (Colonial Pipeline Company, n.d.; Piedmont Natural Gas Company, Inc., 2016; Williams, Inc., 2017) warn that exposure to natural gas and liquid gasoline may immediately cause skin and eye irritation, drowsiness, or dizziness. Prolonged or repeated exposure may cause genetic defects, cancer, and damaged organs, and may impact the health of unborn children. In addition, natural gas may be fatal if it enters airways, and liquid gas may be fatal if swallowed. Table 8.7., located in the Appendix H, outlines the hazard level of the materials transported by pipelines in Davidson.

According to incident reports filed with the PHMSA (2017b), between 2007 and 2016 the United States experienced 2,867 significant pipeline incidents that resulted in 130 fatalities, 641 injuries, and over \$3

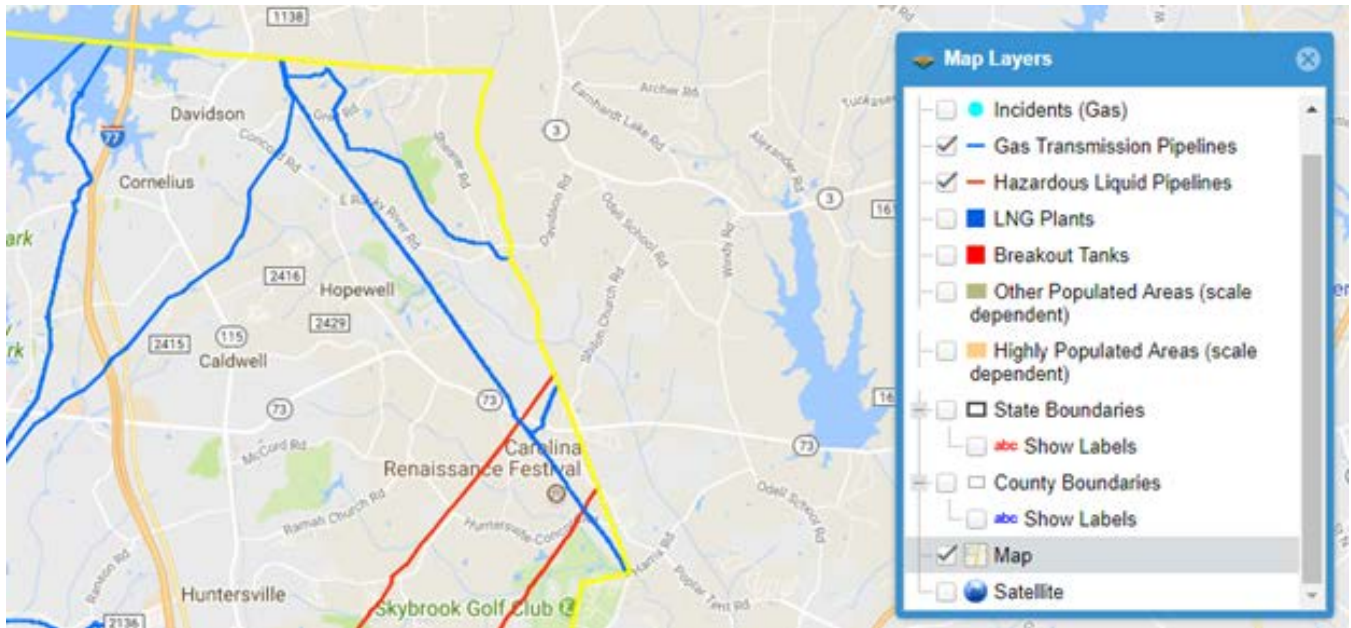


billion in total costs. Of these reported incidents, the 18 that occurred in North Carolina resulted in zero fatalities, two injuries, and over \$6 million in total costs. Three significant pipeline incidents have occurred in Mecklenburg County since 2007, resulting in zero fatalities, zero injuries, and roughly \$510,000 in total costs. Because the potential consequences of a significant pipeline incident include property damage, injury, and death, the MPA team assigned impact a PRI value of 3.

Spatial Extent

Pipelines transmitting natural gas and liquid gasoline run through portions of West Davidson, East Davidson, and the ETJ. A significant pipeline incident could impact citizens in all three of these areas. Figure 4.4. visualizes the system of pipelines that operate within the town’s jurisdiction.

Figure 4.4
Gas transmission and hazardous liquid pipelines in Davidson



Source: National Pipeline Mapping System

Because natural gas and liquid gasoline are highly flammable hazardous materials, a significant pipeline incident would most likely result in a fire. Depending on its location, a fire caused by a pipeline incident could ignite nearby structures, vegetation, or wild land. As such, the spatial extent of a pipeline incident in Davidson should be regarded similarly to that of a structure fire or wildfire.

In addition to creating a fire, a significant pipeline incident involving natural gas could be hazardous to human and animal health. To protect residents from burn injury and avoid exposure to leaked natural gas, the Pipeline Association for Public Awareness (2016) suggests an evacuation radius calculated by the size of a pipeline and its gauge pressure level, measured in pounds per square inch. Evacuation distances range from 91 feet to 4,492 feet. Considering the total square footage of Davidson and the ETJ, a significant pipeline incident involving a large pipeline with high pressure could require the evacuation of residents living in roughly 6.5% of Davidson.



Consistent with the spatial extent value assigned to structure fire and wildfire hazards, as well as the calculation that less than 10% of the town and the ETJ could be evacuated following a large pipeline incident, the MPA team assigned spatial extent a PRI value of 2.

Warning Time

Because the PHMSA (2014a) defines a pipeline accident as an unintentional release of hazardous materials from a pipeline, the MPA team assigned warning time a PRI value of 4.

Duration

The severity and impact of a significant pipeline incident is situational and evaluated by emergency responders, who may require that an affected area stay evacuated until it is no longer at risk for a fire (Pipeline Association for Public Awareness, 2017). Because a significant pipeline incident is likely to cause a fire affecting nearby structures, vegetation, and wildland, the duration of an incident in Davidson should be regarded similarly to that of a structure fire or wildfire. Historically, wildfires in Davidson are contained within less than 24 hours; structure fires in Davidson are contained in less than 6 hours. Consistent with the duration value assigned to wildfires and assuming that a significant pipeline event will leave an affected area vulnerable to a structure fire, the MPA team assigned duration a PRI value of 2.



Earthquakes

An earthquake is the sudden shaking of the ground as a result of movements within the earth’s crust or volcanic action. The area from which an earthquake originates is referred to as a seismic zone or epicenter (Oxford, 2017).

Earthquakes are measured using the Modified Mercalli Scale and the Richter Magnitude Scale, detailed in Figure 4.5. Both methods of measurement assign a numerical value to a description of the earthquake. The Richter Scale measures the amplitude of an earthquake by the peak height of its largest seismic wave. The Modified Mercalli Scale is a relative scale that measures the intensity of an earthquake based on responses from local people and the environment. Although each scale measure impact differently, both are important to understanding the total effect of an earthquake on a community. The Richter Scale is the most used scale on an international level because it is an absolute scale (Diffen, 2017).

Figure 4.5
Comparison of the Modified Mercalli and Richter Scales

Intensity (Mercalli)	Observations (Mercalli)	Richter Scale Magnitude (approx. comparison)
I	No effect	1 to 2
II	Noticed only by sensitive people	2 to 3
III	Resembles vibrations caused by heavy traffic	3 to 4
IV	Felt by people walking; rocking of free standing objects	4
V	Sleepers awakened; bells ring	4 to 5
VI	Trees sway, some damage from falling objects	5 to 6
VII	General alarm, cracking of walls	6
VIII	Chimneys fall and some damage to building	6 to 7
IX	Ground crack, houses begin to collapse, pipes break	7
X	Ground badly cracked, many buildings destroyed. Some landslides	7 to 8
XI	Few buildings remain standing, bridges destroyed.	8
XII	Total destruction; objects thrown in air, shaking and distortion of ground	8 or greater

Source: Diffen

The overall PRI value for earthquakes is 2.2. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

PRI SCORE

2.2

PROBABILITY

Possible	2
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IMPACT

Minor	1
-------	---

SPATIAL EXTENT

Large	4
-------	---

WARNING TIME

< 6 hours	4
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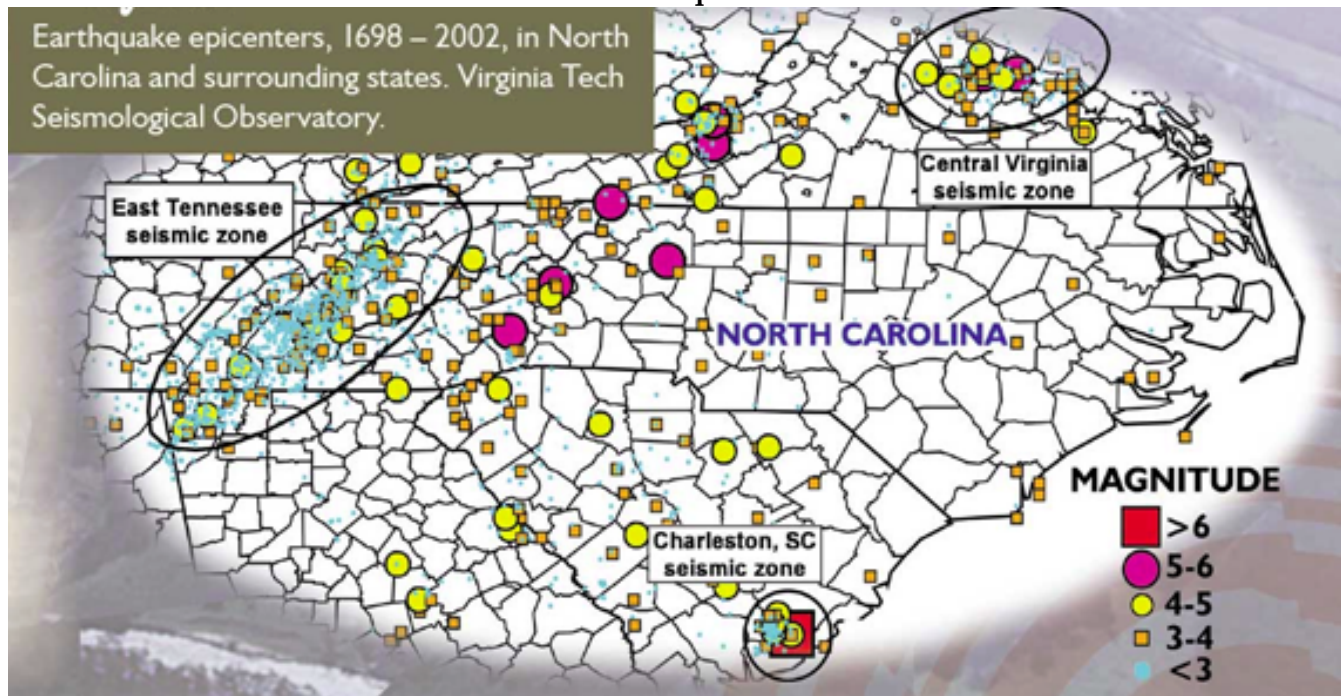
DURATION

< 6 hours	1
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Probability

North Carolina is not situated on any fault lines and does not contain any seismic zones, and is therefore at minimal risk for experiencing an earthquake. However, three major seismic zones are located near North Carolina in East Tennessee, Central Virginia, and Charleston, South Carolina (North Carolina Department of Environmental Quality, n.d.-a). Due to the proximity of these seismic zones, North Carolina can still feel the effects of an earthquake originating in neighboring states, as illustrated by the events depicted in Figure 4.6.

Figure 4.6
Seismic Zones & Recorded Earthquake Events in North Carolina



Source: NCDEQ

Although Davidson does not directly border any of these seismic zones, Mecklenburg County has a 5% probability rate of experiencing an earthquake event (AECOM, 2015) and the town has been shaken by past earthquakes. On November 22, 1974, Davidson reported experiencing the effects of an earthquake that had originated over 296 miles away and registered a magnitude of 4.7 on the Richter Scale (Stover, Simon, & Person, 1976). On June 5, 1998, Davidson felt an earthquake originating a mere 1.9 miles from the town. This earthquake registered a magnitude of 3.2 on the Richter Scale (Earthquake Track, 2017). Because Mecklenburg County may experience an earthquake in any given year and Davidson has recorded earthquake activity in the past, the MPA team assigned probability a PRI value of 2.

Impact

Significant earthquakes can result in the destruction of property and infrastructure and major loss of life. Notably, the southeast portion of North Carolina experienced severe property damage during an 1886 earthquake originating in Charleston, SC (SCEC, 2017). The earthquake measured 7.3 at its peak



magnitude. Several communities, including Charlotte, reported property damage such as downed chimneys, fallen plaster, and cracked walls.

Davidson has not sustained major damage from earthquakes felt in the town. This is because no earthquakes measuring higher than a five on the Modified Mercalli Scale have been recorded in Davidson (Stover, Simon, & Person, 1976). If the town were to experience the effects of a significant earthquake, vulnerable sites like Davidson's historic buildings could be damaged. However, it is unlikely that Davidson will be impacted by a significant earthquake as the town is located far away from seismic zones and fault lines. If an earthquake were to occur in Davidson, the most likely outcome would be minor property damage with little to no interruption of everyday activities. On this basis, the MPA team assigned impact a PRI value of 1.

Spatial Extent

Earthquakes that occur in the central and eastern parts of the United States are felt over a wider geographic expanse than those that occur on the west coast, primarily due to the larger size of the fault zones in these areas (USGS, 2017). While the majority of the earthquakes felt in Davidson originate far west of the town along the Blue Ridge Mountain fault line, all of Davidson would experience the effects of an earthquake events due to its small size. As such, the MPA team assigned spatial extent a PRI value of 4.

Warning Time

The amount of warning time given before an earthquake depends on the distance from the rupturing fault line, the earthquake's depth, and the speed at which an earthquake warning system can gather data and convey information. Distance is the most important factor in determining how quickly a warning message can be relayed (SWS, 2017). Because Davidson is located only 150 miles away from the nearest fault line, an earthquake would be felt within seconds, reducing the town's ability to quickly provide adequate warning. Because Davidson would have very little time to properly warn its citizens of an earthquake event, the MPA team assigned warning time a PRI value of 4.

Duration

Earthquakes typically last for a few seconds (University of Utah, 2017). During a moderate to large earthquake, strong ground shaking may last up to 30 seconds. Following the original earthquake, aftershocks may occur for weeks or months. These aftershocks typically occur in short bursts (University of Utah, 2017). On this basis, the MPA team assigned duration a PRI value of 1.



Dam Failures

Dams are barriers constructed to hold back flowing water for the provision of drinking water, hydroelectric power, irrigation, or even recreation. Dam failure occurs when a dam structure can no longer contain this flowing water. According to the Association of State Dam Safety Officials (ASDSO), dam failure is caused by extreme weather events, overtopping (water spilling over the top of the dam, typically due to inadequate design), piping (sinkholes forming in the dam due to the buildup of improperly filtered soil particles), deterioration or poor condition, foundation deficiencies, or direct sabotage. Extreme weather events are the most common cause of dam failure (ASDSO, n.d.-c).

The National Inventory of Dams (NID) catalogs all dams in the United States that meet at least one of the following criteria:

1. High hazard classification - loss of human life is likely if the dam fails
2. Significant hazard classification - potential loss of human life and likely significant property or environmental destruction if the dam fails
3. Dam size equals or exceeds 25 feet in height and exceeds 15 acre-feet of storage
4. Dam size equals or exceeds 6 feet in height and exceeds 50 acre-feet of storage

Based on NID hazard classifications, four potentially hazardous dams pose a risk to Davidson: Alex Porter dam, Lowe’s CSC dam, Beaty dam, and McConnell dam. Table 4.5. summarizes the length, height, and hazard classification for these four dams.

PRI SCORE

2.1



PROBABILITY

Unlikely 1

IMPACT

Critical 3

SPATIAL EXTENT

Small 2

WARNING TIME

12 to 24 hours 2

DURATION

< 1 week 3



Table 4.5
Hazard Dams in Davidson

Dam Name	Dam Length (Ft.)	Dam Height (Ft.)	Hazard Classification
ALEX PORTER DAM	303	27.5	HIGH
LOWE'S CSC DAM	400	36.9	SIGNIFICANT
BEATY DAM	310	12.7	SIGNIFICANT
MCCONNELL DAM	153	15	SIGNIFICANT

Source: National Inventory of Dams

The overall PRI value for dam failure is 2.1. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

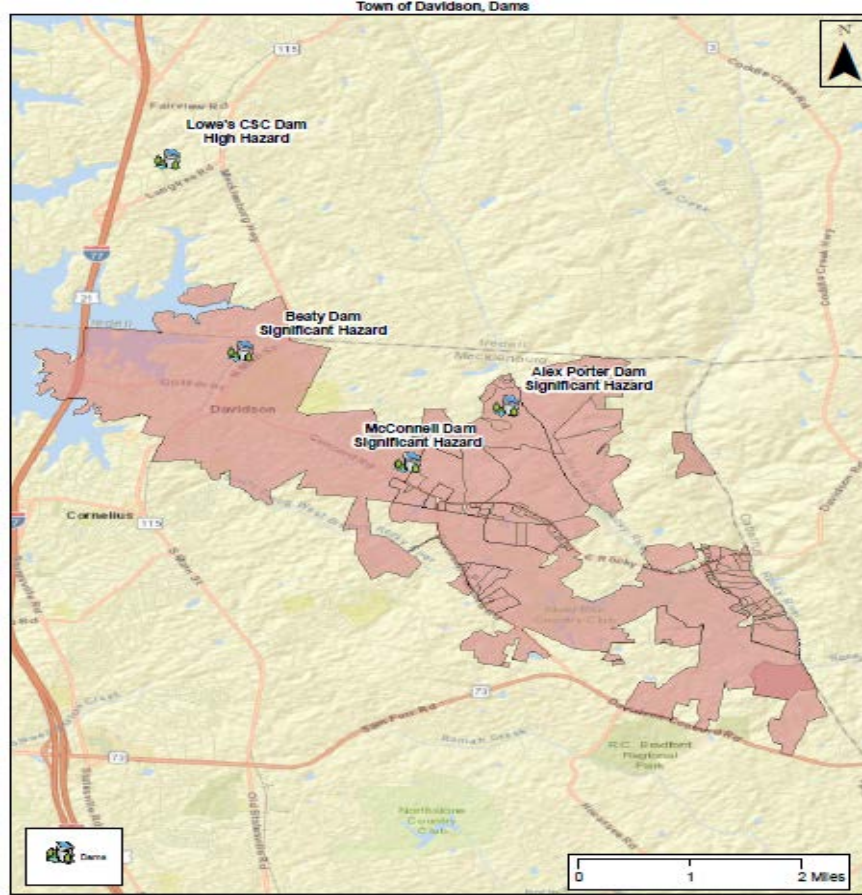
According to the ASDSO, an estimated 173 dam failures occurred in the United States between January 1, 2005 and June 30, 2013 (ASDSO, n.d-a). With over 87,000 dams in the United States, the incident rate of dam failure is less than one percent nationally (FEMA, 2017a). Dam failure has never occurred in Davidson. Due to the low dam failure rate nationally, and the small number of dams potentially hazardous to Davidson, the MPA team assigned probability a PRI value of 1.

Impact

Figure 4.7 shows the location of the four potentially hazardous dams located in or near Davidson.



Figure 4.7
High and Significant Hazard Classification Dams



Source: National Inventory of Dams

Situated approximately two miles upstream from Davidson, Lowe’s CSC dam is classified by NID as a high hazard dam, indicating that loss of human life is likely in the event of dam failure. Three other potentially hazardous dams (Alex Porter dam, Beaty dam, and McConnell dam) are located within town limits. All three have been classified as significant hazard dams by NID. If dam failure were to occur in any of these dams, the potential exists for loss of human life and significant property or environmental destruction. Based on the proximity of these four dams to Davidson and their NID hazard classifications, the MPA team assigned impact a PRI value of 3.

Spatial Extent

The North Carolina Department of Environmental Quality (NCDEQ) states that mitigation efforts should extend for two miles downstream of a hazardous dam to “ensure containment of the breach flood within channel limits” (NCDEQ, 2010). Provided the location of the four hazardous dams in or near Davidson and the two mile mitigation zone suggested by the NCDEQ, the MPA team assigned spatial extent a PRI value of 2.



Warning Time

As dam failures could occur at any moment, it is difficult to determine the full extent of warning time for any given incident. Dam failure could transpire within hours of, or more than a day after, an initial breach (FEMA, 2017d). Additionally, instant failure is an unlikely but possible occurrence. Because of its variable nature, the MPA team assigned warning time a PRI value of 2.

Duration

There are no previous incidents of dam failure recorded at any of the four hazard dams in or near Davidson, and as such, the duration of a dam failure event in the town may only be estimated. Were failure to occur at any of these four dams, its continuance would likely be consistent with other dam failure episodes recorded nationally. The ASDSO provides a baseline for predicting the duration of a dam failure event by examining case studies on historical dam failures. Included in these case studies are a number of major dam failures like the Lake Delhi dam failure in Iowa during 2010 and the Folsom dam failure in California during 1995, among several others. Findings from these case studies indicate that the duration of dam failure depends on a number of factors, including but not limited to the size of the dam, the proximity of the dam to residential areas, whether the dam walls experienced a full or partial breach, and the time it takes to clean up the debris of the dam itself as well as any structures destroyed by the sudden release of water (ASDSO, n.d.-b). Considering these variables, the MPA team determined it would take some time for Davidson to recover from dam failure and therefore assigned duration a PRI value of 3.



Drought

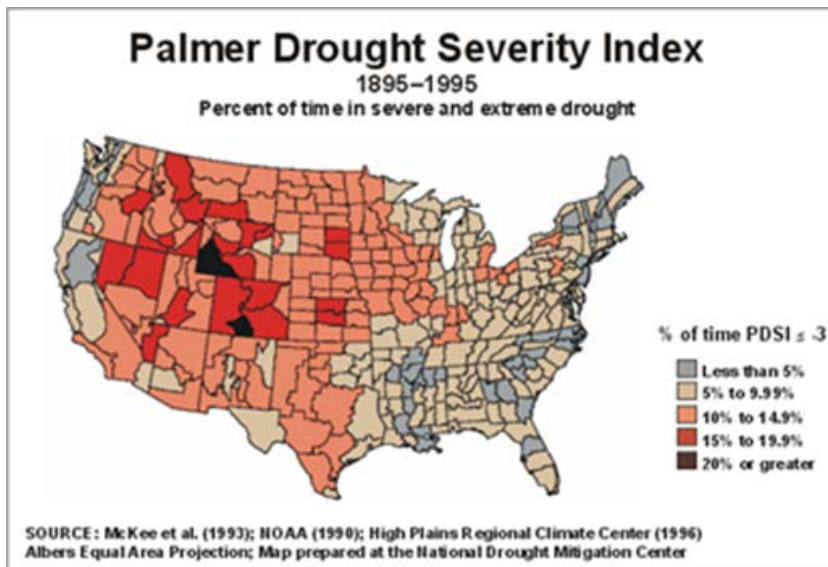
A drought, or water shortage, is typically caused by decreased precipitation; however, human activities that place an increased demand on the water supply can worsen the impact and extent of a drought. A drought is considered a long-term drought if it lasts longer than six months. (National Drought Mitigation Center, n.d.-b).

The overall PRI value for drought is 2.1. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

Mecklenburg County and Iredell County are located in two separate climate divisions: the Southern Piedmont and the Central Piedmont (State Climate Office of North Carolina, n.d.-b). Over the past century, the Southern Piedmont has spent less than 5% of time in severe to extreme drought and the Central Piedmont has spent from 5% to 9.99% of time in severe to extreme drought (Figure 4.8.). Considering that over the past century, Mecklenburg County and Iredell County experienced severe to extreme droughts less than 10% of the time (Figure 4.8.), the MPA team gave droughts a PRI value of 2 for probability.

Figure 4.8
Percent of Time in Severe and Extreme Drought 1895-1995



Source: National Drought Mitigation Center

PRI SCORE

2.1



PROBABILITY

Possible 2

IMPACT

Limited 2

SPATIAL EXTENT

Small 2

WARNING TIME

> 24 hours 1

DURATION

> 1 week 4



Impact

Droughts may have several impacts including increased wildfire risk, decreased agricultural production, and restrictions on water usage (United States Drought Monitor, n.d.; Office of the Press Secretary, 2016.). North Carolina experienced widespread, record setting droughts from 1998 to 2002 and 2007 to 2008. These droughts both resulted in mandatory water restrictions for residents and businesses, and economic loss due to decreased agricultural production (Weaver, 2005; North Carolina Drought Management Advisory Council, 2009). At the height of the 1998 to 2002 drought, around 250 North Carolina municipalities operated under some form of water conservation restrictions (Weaver, 2005). Additionally, the N.C. Division of Forest Resources responded to 30% more wildfires during 2007 than North Carolina's typical yearly average (North Carolina Drought Management Advisory Council, 2009).

Agriculture-based industries typically experience the most direct impacts, such as economic loss, during times of severe to extreme drought. However, because agriculture is not a large industry in Davidson, the town would likely experience less direct impacts than other towns in North Carolina. Regardless, regional losses may still affect Davidson indirectly, and a long-term drought could increase Davidson's wildfire risk. Additionally, Davidson could still experience mandatory water restrictions. On this basis, the MPA team gave droughts a PRI value of 2 for impact.

Spatial Extent

Davidson is largely urbanized with few agriculture-based industries which are particularly vulnerable to extreme drought. During a severe to extreme drought, Davidson might experience an increased wildfire risk. However, this risk would likely only cause impacts for a small portion of the town. Additionally, mandatory water restrictions would likely only have noticeable impacts for businesses and residents that frequently use a high amount of water. Given this, the MPA team determined the PRI value for spatial extent to be 2.

Warning Time

To help communities prepare for the potential impacts of drought, both the U.S. Drought Monitor and Catawba-Wateree Drought Management Advisory Group (CW-DMAG) monitor drought conditions on a weekly basis and provide information on current conditions as well as future probability. Given this information, the PRI value for warning time is 1.

Duration

While severity may vary, droughts can last for weeks, months, or even years, as indicated by the severe to extreme droughts North Carolina experienced from 1998 to 2002 and 2007 to 2008. Considering this, the MPA team determined the PRI value for duration to be 4.



Terrorism & Active Shooter Events

The Code of Federal Regulations defines terrorism as “the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives” (28 C.F.R. Section 0.85).

U.S. government agencies—including the White House, U.S. Department of Justice/FBI, U.S. Department of Education, and U.S. Department of Homeland Security/Federal Emergency Management Agency—collectively define an active shooter event as one “involving an individual [or individuals] actively engaged in killing or attempting to kill people in a confined and populated area” (Blair & Schweit, 2014, p. 5).

The key factor that distinguishes a regular active shooter event from a legal act of terrorism is the actor’s intent. Actors often use threats of force or violence to create fear among the public, to attempt to convince citizens that their government is powerless to prevent terrorism, and/or to get immediate publicity for their causes (Federal Emergency Management Agency, 2013). Though this is true for terrorism, it does not always apply to active shooter events. Per the FBI, active shooter events could be caused by an unresolved real or perceived grievance and the belief that a violent act is the only way to resolve it (Schweit, 2013).

The overall PRI value for terrorism and active shooter events is 2.1. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

Experts classify terrorism and active shooter events as high impact, low probability incidents (Committee to Review the Department of Homeland Security’s Approach to Risk Analysis and National Research Council, 2010). This means that such events rarely occur, but when they do, their aftermath could be catastrophic. The data maintained by the Global Terrorism Database (GTD) reinforces the rarity of such events.

PRI SCORE

2.1



PROBABILITY

Unlikely	1
----------	---

IMPACT

Critical	3
----------	---

SPATIAL EXTENT

Small	2
-------	---

WARNING TIME

< 6 hours	4
-----------	---

DURATION

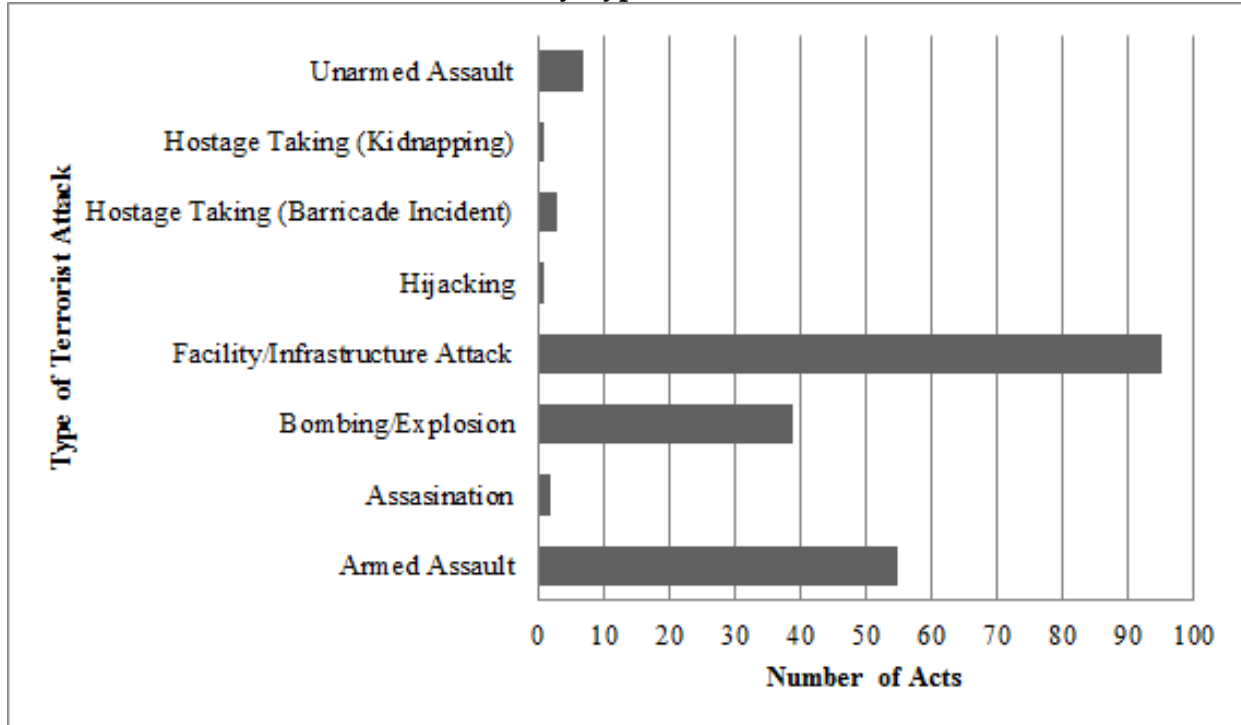
< 6 hours	1
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The GTD documents every act of terrorism that has occurred around the world since 1970 (National Consortium for the Study of Terrorism, 2016). Per the GTD, there have been only 196 confirmed acts of terrorism in the U.S. from 2006 to 2016.

As illustrated in Figure 4.9, the most common type of terrorist act that occurred during this period was infrastructure/facilities attacks (with 95 recorded incidents). Hijackings and hostage taking-kidnapping events were the least common types of terrorist acts (with one recorded incident each).

Figure 4.9
Acts of terrorism By Type in the U.S. 2006 - 2016

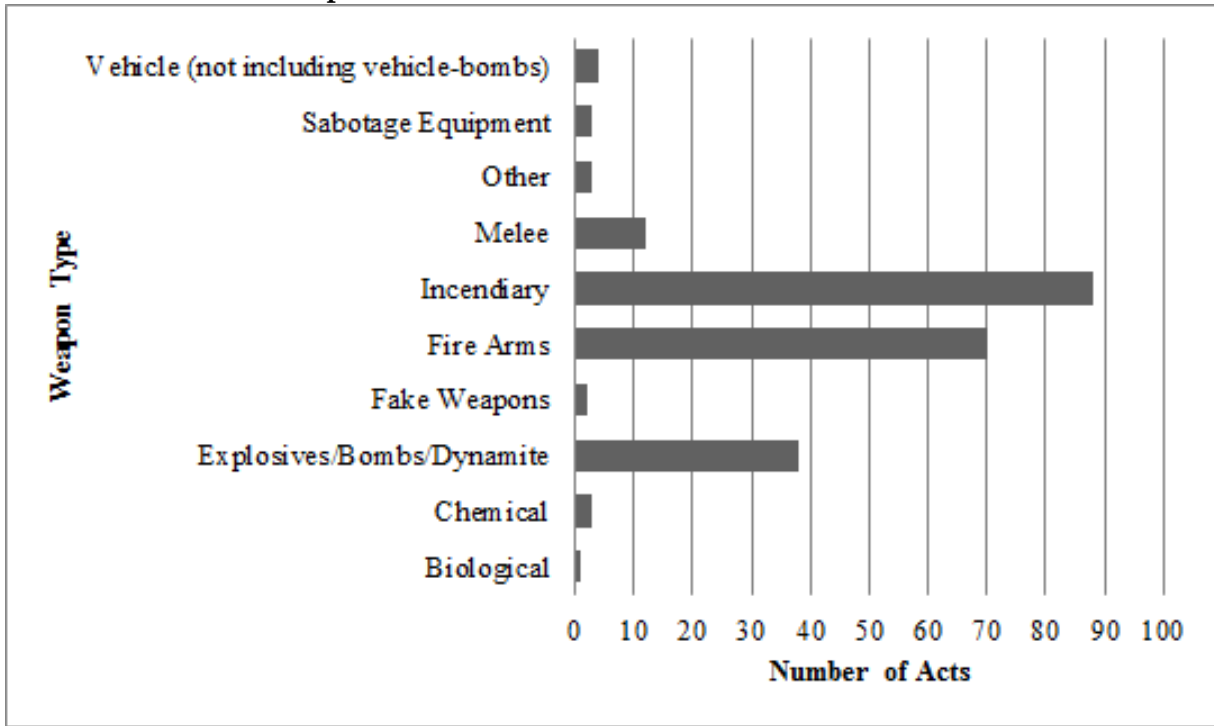


Source: Global Terrorism Database

Per Figure 4.10., incendiary weapons -- weapons capable of catching and/or causing fire, or burning readily and producing an intensely hot fire when exploded -- were used most frequently in acts of terrorism that occurred during this period (with 88 reported incidents). With only one reported incident, biological weapons were used the least in acts of terrorism.



Figure 4.10
Weapons Used in U.S. Acts of Terrorism 2006 - 2016

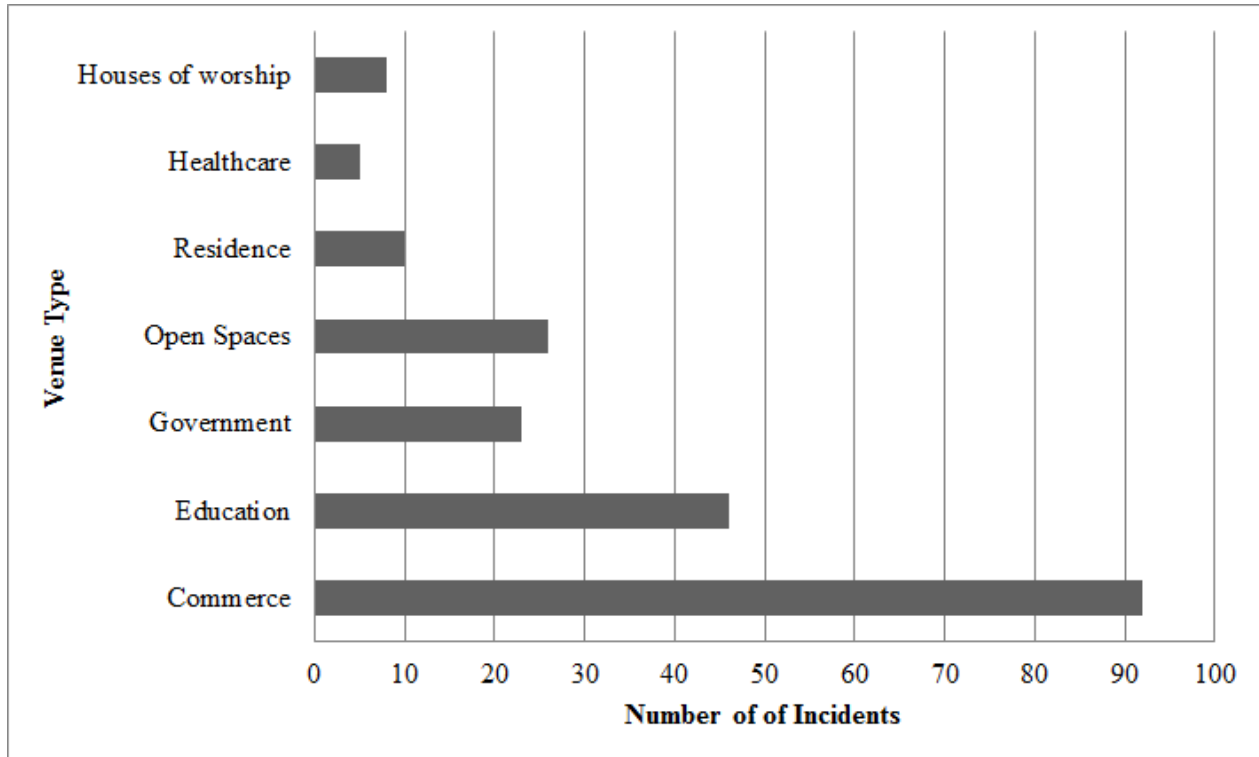


Source: Global Terrorism Database

Because they do not always receive the terrorism designation, the GTD may not capture all active shooter events. However, the FBI does maintain data on all active shooter events regardless of their designation. Per FBI records, there have been 210 active shooter events nationwide between 2006 and 2016. The most common venue for these attacks, as illustrated in Figure 4.11., was areas of commerce. Areas of commerce included businesses open to pedestrian traffic, businesses closed to pedestrian traffic, and malls (with 92 reported incidents). Healthcare facilities were the least targeted type of venue (with 5 reported incidents).



Figure 4.11
Active Shooter Events in the U.S. 2006 - 2016



Source: Federal Bureau of Investigation

Locally, there have been only nine total acts of terrorism or active shooting events in the state of North Carolina between 2006 and 2016, none of which occurred within Davidson (see Appendix I). The closest incident occurred approximately 20 miles away in the City of Charlotte in 2015, during which assailants set fire to a church but did not cause any deaths or injuries (National Consortium for the Study of Terrorism, 2016). Given this information, it is unlikely that Davidson would experience an act of terrorism or an active shooter event. Because of the rarity of these events, the MPA team assigned this category a PRI value of 1.

Impact

Generally, terrorism and active shooter events can lead to human injury or loss of life, and psychological harm. In addition, terrorism and active shooter events carry with them potentially negative economic impacts if an attack takes place in an area that is important for commerce. The occurrence of biological, nuclear, radiological, and chemical attacks have further unique effects; more information about these specific impacts can be found in Table 8. 10. located in Appendix J.

Davidson is more likely to experience an active shooter event and its resulting consequences than a terrorist attack. The worst-case scenario for Davidson could be similar to the worst active shooter event to take place in the state of North Carolina. On March 29, 2009, Robert Kenneth Stuart killed eight people and wounded three others, including an officer, at the Pinelake Health and Rehabilitation Center in the Town of Carthage. Armed with several firearms, Stuart was unsuccessfully searching for



his estranged wife, who was an employee at the Center (Blair & Schweit, 2014). Carthage Police, the State Bureau of Investigation, and Moore County Sheriff's Department were all involved in the response and resulting investigation (Associated Press, 2009). In addition to the law enforcement response, Firsthealth Moore Regional Hospital received six of the victims by ambulance (Sulzberger & Binker, 2006). In similar fashion, Davidson would have to deploy all available public safety agencies to secure the scene and administer emergency care to victims during an active shooter event. Additionally, the victims and town residents may experience psychological impacts following the event that disrupt daily life. These factors led the MPA team to assign this category a PRI value of 3.

Spatial Extent

The spatial extent of a terrorism or active shooter event will vary depending on the type of attack. An event like a radiological attack could affect a space smaller than a city block (National Academies & U.S. Department of Homeland Security, 2004c). Conversely, an event could impact multiple sites in multiple states, as was the case during the attacks of September 11, 2001 ("9/11 Attacks", 2010). However, based on North Carolina's history of terrorism and active shooter events between 2000 and 2016, Davidson would most likely experience an active shooter event in a small venue (Federal Bureau of Investigation, 2017); therefore, the MPA team gave this category a PRI value of 2.

Warning Time

Terrorism and active shooter events are difficult to predict due to a lack of historical incidents for experts to study (Committee to Review the Department of Homeland Security's Approach to Risk Analysis & National Research Council, 2010). There are no common patterns or forecast models available to predict when, where, and how an attack would occur (Committee to Review the Department of Homeland Security's Approach to Risk Analysis & National Research Council, 2010). As such, the MPA team assigned this category the highest possible PRI value of 4.

Duration

Duration of an act of terrorism varies depending on the characteristics of the attack. Per the FBI's records, active shooter events specifically have historically lasted anywhere from two to 22 minutes (Blair & Schweit, 2014). As a result, the MPA team assigned this category a PRI value of 1.



Hazardous Material: Transportation Incidents

Dangerous substances may be released into the environment if a truck transporting hazardous materials is involved in an incident along a major highway. According to the Pipeline and Hazardous Materials Safety Administration (PHMSA) (2011), hazardous materials can be released while in transit because of:

- Vehicle rollover
- Human error
- Malfunction of a component or device
- Vehicular crash or accident
- Fire, temperature, or heat
- Impact with a sharp or protruding object
- Overpressurization
- Inadequate or improper preparation for transportation

The overall PRI value for a transportation incident involving hazardous materials is 2.1. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

Transportation incidents involving hazardous materials are infrequent. This is due, in part, to the acute awareness that shippers and carriers have of the risks involved with transporting hazardous materials (DOE Transportation Risk Assessment Working Group Technical Subcommittee, 2002). Regulations by the Department of Transportation ensure that shipments are prepared with extreme caution and employees are trained on safe transportation and incident response techniques.

Table 8.8., located in Appendix K, provides incident counts for crashes involving hazardous materials. According to the Federal Motor Carrier Safety Administration (2017), the United States experienced 3,684 total crashes involving a truck transporting hazardous materials in 2015 (the most recent reporting year). Of these, only 490 resulted in the release of hazardous materials. Incident reports filed to the PHMSA’s Office of Hazardous Materials Safety (2017a) indicate that, since the beginning of 2007, there have been 674 total crashes or derailments in North Carolina that resulted

PRI SCORE

2.1



PROBABILITY

Unlikely	1
----------	---

IMPACT

Critical	3
----------	---

SPATIAL EXTENT

Small	2
-------	---

WARNING TIME

< 6 hours	4
--------------	---

DURATION

< 6 hours	1
--------------	---



in the release of hazardous materials. There have been no hazardous material transportation incidents reported in Davidson in the past ten years. Table 4.6. outlines the one recorded hazardous material transportation incident near Davidson in the Town of Mooresville.

Table 4.6
Significant hazardous material transportation incidents near Davidson, 2007-2017

Date	Location	Carrier	Serious incident?	Total HazMat fatalities	Total HazMat injuries	Total amount of damages	Commodity	Quantity released
7/8/10	Mooresville	UPS Ground Freight	No	0	0	\$2,000	Carbon Dioxide, refrigerated liquid	.25 liquid gallons

Source: Pipeline and Hazardous Materials Safety Administration

Because transportation incidents involving hazardous materials do not historically impact Mecklenburg County and only a few miles of highway roads run through Davidson, the MPA team assigned probability a PRI value of 1. However, transportation incidents involving hazardous materials do happen every year in North Carolina and an accident occurring on I-77 or NC-115 is not out of the question.

Impact

Incidents involving hazardous materials vary in consequence. Factors like the type of hazardous material transported, the quantity of roads in a region, the concentration of traffic on a road at any given time, the quality of road maintenance efforts, and the quality and type of preventative measures practiced by drivers could all influence the level of severity of an incident (Debray, Affeltranger, Vincent, and Coutto, 2007). Additionally, the impact of a hazardous material spill depends on the quantity and nature of the dangerous substance released. For example, a gasoline spill can be of high concern because it is transported in large volumes and is extremely flammable (New Jersey Department of Health [NJDOH], 2016b). Conversely, while sulfuric acid is transported in smaller quantities than gasoline, the volatility of the substance makes its exposure extremely dangerous (NJDOH, 2016e). According to the PHMSA (2011), from 2005 to 2009, the top ten commodities that produced the largest number of high-impact casualties (defined as the number of fatalities plus major injuries or hospitalization), ranked by highest to lowest consequence, are:

1. Gasoline
2. Chlorine
3. Diesel fuel
4. Propylene
5. Fireworks
6. Liquefied petroleum gas (LPG)
7. Carbon dioxide, refrigerated liquid



8. Sulfuric acid
9. Argon, refrigerated liquid
10. Propane

Most of these hazardous materials—like gasoline, propane, and propylene—present an extreme flammability risk (NJDOH, 2016b; NJDOH, 2016c; NJDOH, 2016d). Others, like chlorine, are highly toxic to humans and animals and extremely volatile when reacting with other chemical agents (NJDOH, 2016a). As such, an incident on a highway in or near Davidson may release hazardous material into the surrounding environment and cause a fire (if highly flammable substances are involved), or dangerous exposure to the truck operator and persons traveling alongside the truck (if gases or radioactive, poisonous, or infectious substances are involved).

According to incident reports filed to the PHMSA’s Office of Hazardous Materials Safety (2017a), there have been 674 total crashes or derailments in North Carolina that resulted in the release of hazardous materials since 2007. The consequences of these incidents are spillage, fire, explosion, vapor (gas) dispersion, materials entering a waterway or storm sewer, or environmental damage. These incidents have the following characteristics:

- 0 caused or contributed to a human fatality
- 9 caused or contributed to personal injury
- 22 caused or contributed to an evacuation
- 74 closed a major transportation artery or facility

Although a transportation incident that released hazardous materials into the environment has not led to fatalities in North Carolina in the past decade, such incidents have resulted in death as well as injury and property damage nationally. Because the potential consequences of a transportation incident include property damage, injury, and death, the MPA team assigned impact a PRI value of 3.

Spatial Extent

A transportation incident involving highly flammable substances could result in a fire. A fire caused by an accident may ignite the vehicle transporting the released hazardous materials and/or nearby vehicles. As such, the spatial extent of a transportation incident in Davidson should be regarded similarly to that of a vehicle fire.

In addition to creating a fire, a transportation incident involving hazardous materials could be dangerous to human and animal health. To protect residents from burn injury and avoid exposure to toxic substances, the PHMSA (2016) suggests an initial isolation radius calculated by the type and amount of substance released. Isolation distances typically range from 100 to 500 feet. Consistent with the spatial extent values assigned to structure and vehicle fires, as well as an isolation distance recommendation measured in feet (and not a larger quantity like miles), the MPA team assigned spatial extent a PRI value of 2.

Certain hazardous substances may present an additional risk to an affected area if transmitted by wind or through water. In this instance, the spatial extent of a transportation incident would be greater,



requiring emergency responders to initiate protective and/or evacuation measures for residents living in a multi-mile radius (PHMSA, 2016).

Warning Time

Transportation incidents resulting in the accidental release of hazardous materials, like all vehicle accidents, occur without warning. Because of their unpredictability, the MPA team assigned warning time a PRI value of 4.

Duration

The severity and impact of a transportation incident involving hazardous materials is situational and evaluated by emergency responders, who may require that an affected area stay evacuated until it is no longer at risk for a fire (PHMSA, 2016). Because a transportation incident is likely to cause a fire which could affect nearby vehicles, the duration of an incident in Davidson should be regarded similarly to that of a structure or vehicle fire. Historically, structure and vehicle fires in Davidson have been contained in less than six hours. Consistent with the duration value assigned to structure and vehicles fires, the MPA team assigned duration a PRI value of 1.

Certain hazardous substances may present an additional risk to an affected area if they are transmitted by wind or through water. In this instance, emergency responders may initiate protective and/or evacuation measures for residents living in a multi-mile radius, resulting in containment and cleanup procedure lasting longer than 6 hours (PHMSA, 2016).



Severe Disease Outbreak

The Centers for Disease Control and Prevention (CDC) defines a disease outbreak as “the occurrence of more cases of disease than expected in a given area or among a specific group of people over a particular period of time” (CDC, 2012). These diseases have zero expected cases occurring per year, and the risk of mortality is relatively high compared to frequently occurring infectious diseases. The diseases are infectious, and caused by bacteria, viruses, or other microorganisms. Depending on the disease, it can spread to people by person-to-person transmission, through a host organism with no symptoms, or by exposure in the immediate environment to the microorganisms that cause the disease.

The overall PRI value for severe disease outbreak is 1.9. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

In 2016, local concern about disease outbreak was piqued due to a widely-publicized death resulting from the amoeba *Naegleria fowleri*, a naturally occurring amoeba, found in higher-than-normal concentrations at the U.S. National Whitewater Center (USNWC) in Mecklenburg County (Associated Press, 2016). Although this was an isolated case, it met the CDC definition of an outbreak since the anticipated number of amoeba infections is zero. This local example underscores the need to recognize that, despite low probability, unexpected disease events, such as a vector-borne illness or rare infectious diseases like meningitis or measles, can occur in Davidson.

Vector-borne illnesses account for 17% of infectious disease cases worldwide, and can generate public concern such as was seen after the emergence of the Zika virus. Vector-borne diseases are transmitted from a non-human host organism to people, who become infected (World Health Organization, 2017). Mecklenburg County is at low risk for severe vector-borne diseases that are currently endemic to North America, such as Zika or Dengue Fever. A recent Mecklenburg County Health Department Study found no mosquitoes of the species *Aedes aegypti*, the host organism for those diseases, living in Mecklenburg County (Rapp, 2017). Although there may be

PRI SCORE

1.9



PROBABILITY

Unlikely	1
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IMPACT

Limited	2
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SPATIAL EXTENT

Negligible	1
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WARNING TIME

> 24 hours	4
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DURATION

> 1 week	4
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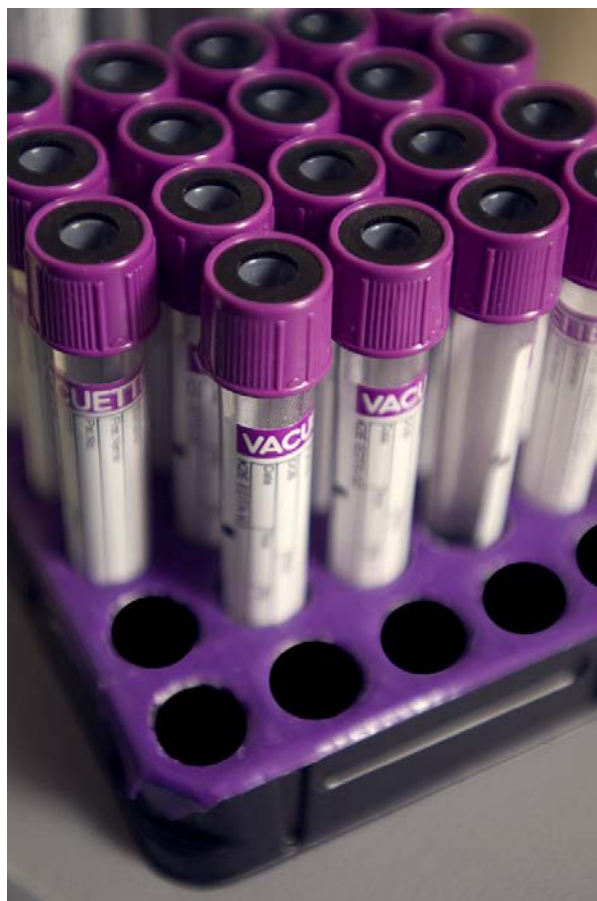
public concern about mosquito vector-borne diseases, the probability of many of the most serious vector borne illnesses is essentially zero until this mosquito species returns to Mecklenburg County.

Outbreaks of diseases such as meningitis and measles can occur on college campuses. These diseases are contagious and can be transmitted between students who are unvaccinated or vaccinated but not immune. There were five meningitis outbreaks on college campuses in the United States from 2013 to 2016 (National Meningitis Association, n.d.). However, Davidson College has no history of these outbreaks, and there were no meningitis outbreaks at colleges or universities in North Carolina during the 2013 to 2016 timeframe.

The MPA team found no record of recent severe disease outbreaks in Davidson. As a result, the MPA team assigned probability a PRI value of 1.

Impact

Severe disease outbreaks can lead to illness, death, quarantine, or the shutdown of facilities to prevent disease transmission. Disease impact has been limited due to the continued improvement of medical technologies (McKeown, 2009). Those technologies allow prevention through vaccination and treatment before exposed people exhibit symptoms. More people survive illnesses now than in historic



outbreaks because of contemporary treatment technologies (CDC, 2017).

The most significant historical disease outbreak to reach Davidson occurred in 1918, when an influenza pandemic caused the deaths of more than 50 million people worldwide, including 675,000 in the United States. This epidemic occurred without the protection of vaccine prevention or medications for the illness. The 2009 pandemic of a similar influenza strain resulted in markedly less worldwide incidence and mortality, in part due to an increase in biomedical technologies (CDC, 2017).

Despite the infrequent occurrence of severe disease outbreaks and the ability to control them with medical technology, the impact of even a single severe case can be disruptive. The amoeba infection that began at the USNWC led to suspension of activities and rigorous cleaning at the facility to prevent any further loss of life (Associated Press, 2016). Because of the effectiveness of the medical field in responding to disease outbreaks, the MPA team assigned impact a PRI value of 2.

Source: CDC, Amanda Mills



Spatial Extent

The number of people affected by severe disease outbreaks is usually small due to the quality of healthcare infrastructure found in the United States (McKeown, 2009). For example, domestic meningitis outbreaks in the last decade have ranged in size from two to nine people (National Meningitis Association, n.d.). The tendency of these outbreaks to occur in single locations at a time, and the geographic limitations resulting from the small pool of cases led the MPA team to assign spatial extent a PRI value of 1.

Warning Time

Warning time for disease outbreaks varies by disease type and exposure (Woolhouse, 2011). Outbreaks that begin outside of the town provide significant lead time for preparation. However, should an infection originate in the town, a disease could spread without warning. The cases that pose the most significant risk to Davidson and its emergency responders are diseases that occur without warning. The MPA team, therefore, assigned warning time a PRI value of 4.

Duration

Duration of an outbreak depends on the disease (Viboud, Simonson, & Chowell, 2016). The duration of an outbreak-related crisis lasts from the discovery of the first case until the end of the incubation period for other cases. The incubation period is the time from exposure and infection with a pathogen until the presentation of symptoms. The incubation period for meningococcal meningitis, for example, is 2 to 10 days; therefore, a meningitis crisis in Davidson would last from the first case until 10 days past the end of symptoms for the last case (World Health Organization, 2015). Based on this information, the MPA team assigned duration a PRI value of 4.



Flood

A flood is the overflowing of water into normally dry land areas. Flooding occurs when surface water accumulates rapidly and is released from a lake, river, creek, canal, dam, or other watercourse. A flood may be caused by events such as excessive rain, ruptured dams or levees, or rapid ice melting (What-When-How, n.d.). Areas alongside streams or rivers that are likely to experience repeated flooding are labeled as floodplains. These areas have been naturally conditioned over time to accept high levels of runoff from surrounding bodies of water. Floodplains can help reduce the possibility of flooding of nearby non-floodplain residential, agricultural, or commercial areas (AECOM, 2012).

The overall PRI value for floods is 1.8. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

The Federal Emergency Management Agency (FEMA) has developed a method of identifying flood prone areas based on the annual risk of flooding. Table 4.7. illustrates the likelihood that a specific flood event may occur in any given year.

Table 4.7
Annual Probability and Reoccurrence Interval

Storm Event	Percent Annual Chance
2 Year	50%
5 Year	20%
10 Year	10%
25 Year	4%
50 Year	2%
100 Year	1%
500 Year	0.2%

Source: Federal Emergency Management Agency

Per federal mandate, flood insurance is required for all federally-related assistance in the acquisition and construction of any building

PRI SCORE

1.8



PROBABILITY

Possible 2

IMPACT

Minor 1

SPATIAL EXTENT

Small 2

WARNING TIME

6 to 12 hours 3

DURATION

> 24 hours 2



in a high-risk flood zone. FEMA has ranked Davidson as an area of low risk with no mandatory flood insurance required of its inhabitants (FEMA, 2014).

With federal flood insurance standards in mind, the NC Flood Risk Information System (n.d.) finds that floodplains located adjacent to the significant bodies of water in Davidson (including the two branches of the Rocky River) have a 0.2% annual chance of flooding. Further analysis of flood risks unique to Davidson has been conducted by Charlotte-Mecklenburg Storm Water Services (CMSWS), the agency responsible for managing and maintaining the regulated floodplains within Mecklenburg County. Taking into account factors like flood impacts, probability of occurrence, and the location of property in the town, CMSWS (2012) identified only 59 buildings in Davidson that lie within a 100-year floodplain (i.e. having a 1% annual chance of flooding). Because local floodplains and buildings have a 1% or less annual chance of experiencing a flood, the MPA team assigned probability a PRI value of 2.

Impact

From 1900 to 2014, no historical flood events directly affected Davidson. The closest notable flood event occurred in Cornelius in 2013 and resulted in flooded roads and streams.

At a regional level, in 1995 Tropical Storm Jerry produced up to 9.37 inches of rainfall, which led to flooding in parts of Mecklenburg County. However, according to the National Flood Insurance Program, Davidson incurred zero losses and \$0 in payments in the wake of Tropical Storm Jerry (AECOM, 2015).

Fifty-nine flood prone buildings in Davidson have been identified by CMSWS as having a 1% annual chance of flooding. The potential impact of flood waters on these 59 buildings varies. Three percent were evaluated at a high risk level, 11% were evaluated as medium risk, and the remaining 74% were evaluated as low risk according to James Scanlon, GIS Analyst from CMSWS. Were a flood to impact these buildings or areas adjacent to floodplains in Davidson, however, it is unlikely that significant property damage or loss of life would be sustained. As such, the MPA team assigned impact a PRI value of 1.

Spatial Extent

If a major flood were to occur in Davidson, the areas located closest to significant water sources would be most heavily affected. The southeastern portion of the town would be impacted by flooding of the West Branch and South Prong of the Rocky River, along which lie FEMA-designated floodways and floodplains that have a 0.2% annual chance of flooding. Specifically, South Prong runs directly through the River Run Country Club neighborhood and very near to the Bailey Springs and Davidson Wood residential neighborhoods. Flood water overflowing from the South Prong could affect homes in these areas. While the West Branch of the Rocky River does not flow through or near residential areas, flooding of this waterway could damage agricultural land. A flood event could also impact the 59 buildings in Davidson designated as flood prone by the CMSWS. Because a small percentage of the town could be affected by a flood, the MPA team gave spatial extent a PRI value of 2.



Warning Time

A flood event in Davidson may be predicted with the aid of two systems. First, water levels of the major bodies of water in the town are constantly monitored by operators at Duke Energy which manages electricity-generating dams located on Lake Norman. If necessary, these operators can adjust the amount of water in a dam, in turn changing water levels in nearby rivers and reducing the risk of overflow and flooding. Duke Energy's procedures ensure that Davidson receives up to a day's notice of a possible flood event if dam operators see a sudden increase in water levels (Duke Energy, 2017a). Second, weather forecasts can give warning of heavy storm patterns that may swell the water level of streams and rivers in Davidson and cause a flood. However, it is difficult to determine the level of intensity and potential consequences of a storm system until it arrives, and flash floods can develop in less than six hours after a major storm event (CMSWS, 2012). Due to these limitations, residents may be alerted to the possibility of flooding in a general area but may not be made aware of specific locations that could flood.

With the aid of monitoring system in place at Lake Norman and weather forecasting services, Davidson would receive between six to twelve hours of notice of a potential flood event. As such, the MPA team assigned warning time a PRI value of 3.

Duration

The duration of a flood event depends on numerous factors, such as the source of the flood and how long rain or water intake occurs. Some floods, like the Great Mississippi Flood of 1927, can last upwards of four to five months (Parrish, 2017). Other floods last only a few hours (FEMA, 2014b). It is likely that a flood in Davidson would be short lived. In the event of a storm, Davidson's 0.2% annual chance floodplains are generally expected to be able to withstand runoff produced by a severe weather event. Additionally, major bodies of water, including Lake Norman, could reduce a period of flooding by helping to absorb storm waters. Therefore, the MPA team assigned duration a PRI value of 2.



Sinkholes

A sinkhole is a depression in the ground that has no natural external surface drainage. There are two types of sinkholes: cover-collapse and cover-subsidence. Cover-collapse sinkholes develop abruptly in a matter of hours and can cause potentially catastrophic damage. Cover-subsidence sinkholes form slowly as the ground gradually subsides or deflates. These sinkholes form over the course of weeks and can still cause potentially catastrophic damage, but often warning signs are evident and preemptive action can be taken (Robertson & Orndorff, 2013).

Sinkholes can be caused both naturally and through man-made events. The two common natural causes of sinkholes are heavy rainfall and drought. Heavy rainfall leads to rainwater beginning to pool underground. If there is improper drainage in a given area, the rainwater becomes acidic and escalates the formation of sinkholes (Earth Networks, 2013). Drought causes the water table of a given area to drop, which leads to a lack of stability throughout the bedrock and soil (Robertson & Orndorff, 2013).

Several man-made activities ranging from simple to complex can also lead to sinkholes. Simple problems, such as a leaky faucet, can lead to small sinkholes. Complex problems, such as groundwater pumping and construction, the altering of water-drainage patterns, and the creation of industrial run-off ponds can lead to major sinkholes (Robertson & Orndorff, 2013). Sinkholes can also form above older infrastructure, such as old mines, aging sewers, and water main pipes (Griffin, 2017). Finally, sinkholes can form as a result of an aquifer system that is drained too low. These types of sinkholes are especially prevalent in urban areas, as more man-made structures equal added weight upon the bedrock surrounding the aquifer (Robertson & Orndorff, 2013).

Sinkholes range in size from a few feet wide to hundreds of acres wide, and from less than a foot to more than 100 feet deep. Sinkholes are the most dramatic if they occur in an urban setting. They can consume swimming pools, roadways, and buildings, and contaminate water resources (Robertson & Orndorff, 2013).

The overall PRI value for sinkholes is 1.6. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

PRI SCORE

1.6



PROBABILITY

Unlikely	1
----------	---

IMPACT

Limited	2
---------	---

SPATIAL EXTENT

Small	1
-------	---

WARNING TIME

< 6 hours	4
-----------	---

DURATION

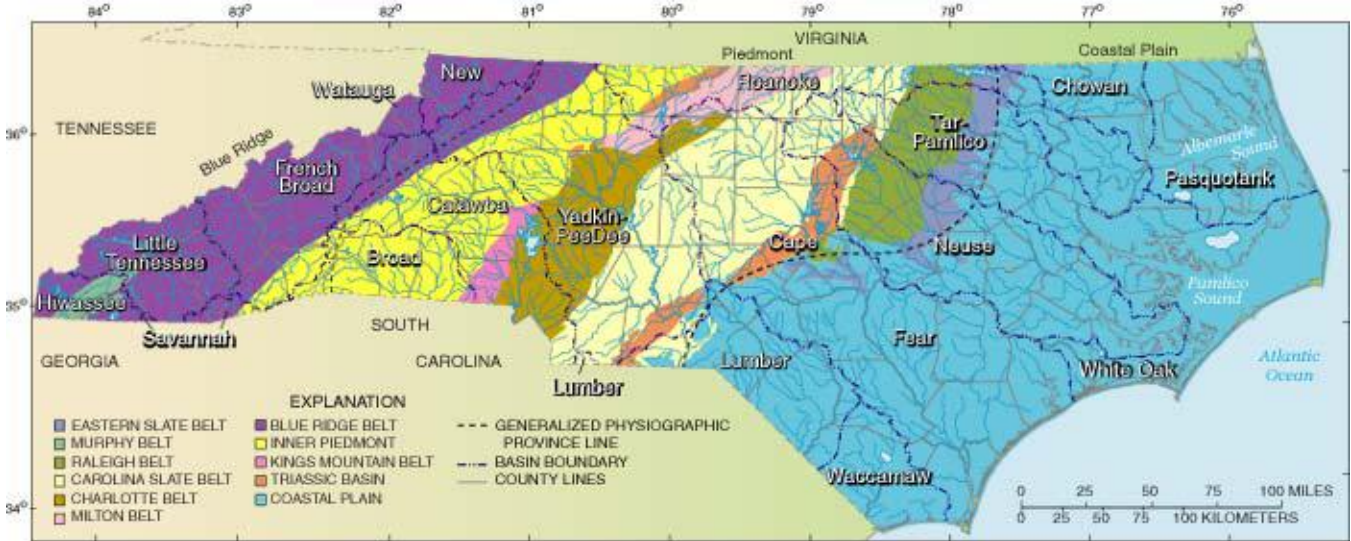
< 6 hours	1
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Probability

Sinkholes form anywhere underground rock composition is soluble. The two most common types of soluble bedrock are limestone and dolomite (Robertson & Orndorff, 2013). Outside of some isolated pockets scattered throughout the state, the abundance of permeable rock in North Carolina is located in the coastal plain, as illustrated in Figure 4.12 (Bales, Chapman, Oblinger, & Robbins, 2016).

Figure 4.12
North Carolina Geologic Formation



Source: United States Geological Survey

Davidson lies in a rock bed dominated by igneous rocks known as the Charlotte Belt (Goldsmith, Milton, & Horton, 1988). Igneous rocks provide very little permeability, as water can only escape through fractures in the rock (United States Geological Survey, 2016). Low rock bed permeability suggests a low probability of sinkholes. Based upon the consistency of the rock within Davidson, the town’s infrastructure is much less vulnerable to sinkholes. For this reason, the MPA team assigned probability a 1 on the PRI scale.

Impact

The possible impact of a sinkhole in Davidson is minor. As rock consistency in the town is not conducive to natural sinkholes, any occurrence would most likely result from man-made activities (Berlin, 2013). However, a minor sinkhole could still cause sufficient damage to property. For example, a sinkhole could affect the foundation of buildings or other infrastructure and could require that an entire structure be rebuilt. For these reasons, the MPA team assigned impact a 2 on the PRI scale.

Spatial Extent

Any sinkhole occurring in Davidson would be small. However, the effects of a sinkhole might extend beyond the circumference of the depressed land. For example, between 1 and 10% of the town would



be affected if key infrastructure (e.g. pipes and roads) were impacted by a sinkhole (Robertson & Orndorff, 2013). For these reasons, the MPA team assigned spatial extent a PRI value of a 2.

Warning Time

The nature of sinkholes does not allow for much forewarning of a possible occurrence. Slight depressions in the land could be visible, but these signs will only materialize a few hours prior to the collapse of the land (Berlin, 2013). For this reason, the MPA team assigned warning time a 4 on the PRI scale.

Duration

Because a sinkhole in Davidson will most likely be small, any occurrence is unlikely to affect the town for an extended period of time. However, a sinkhole below major infrastructure may incapacitate the town for a few days, as was the case when a sinkhole opened beneath N.C. Highway 127 in Hickory, NC. This sinkhole materialized due to the failure of an old storm water culvert under the roadway and caused NC-127 to be shut down for nearly a week while the hole was filled and repaired (Griffin, 2017). Because rock composition in Hickory is different than in Davidson, the MPA team assigned duration a PRI value of 1.



Source: Hickory Record



Landslides

Landslides refer to a range of ground movements, such as rock falls, deep failure of slopes, and shallow debris flows (USGS, n.d.-a). The combination of gravity and an over-steepened slope are the main causes of landslides. Other factors, however, such as erosion, slopes weakened by water saturation from heavy rainfall and snowmelt, stress from earthquakes, and human activities such as excavation could cause a landslide.

The overall PRI value for landslides is 1.1. The sidebar displays the risk levels assigned by the MPA team to each PRI category. The rationale for these numeric values is given below.

Probability

In North Carolina, landslide events are more common in the western part of the state because of its steep slopes, mountainous terrain, and history of prior landslides. In contrast, Mecklenburg County is relatively flat, and has experienced no reported incidents of landslides (NC Department of Environmental Quality, n.d.-b). Considering Davidson does not have high slopes and its rock consistency has a low level of water permeability (which limits water’s ability to penetrate the ground and weaken soil layers), major landslides triggered by natural causes are unlikely to happen. Given this information, the MPA team assigned the probability a PRI value of 1.

Impact

Landslides have the potential to damage to structures and roads, and can cause injuries and deaths. In the United States, landslides produce up to \$2 billion in damages and 25 to 50 deaths annually (Mecklenburg County Hazard Mitigation Plan, 2015). For Davidson, which is more likely to experience minor landslides caused by heavy rain or human activity, significant damage and injuries are unlikely to occur. Therefore, the MPA team assigned impact a PRI value of 1.

Spatial Extent

The spatial extent of a landslide is based upon the cubic yards of earth moved or area shifted and how far the area moved from its original position (Mecklenburg County Hazard Mitigation Plan, 2015). Considering Davidson does not have steep slopes, only minor

PRI SCORE

1.1



PROBABILITY

Unlikely	1
----------	---

IMPACT

Minor	1
-------	---

SPATIAL EXTENT

Negligible	1
------------	---

WARNING TIME

12 to 24 hours	2
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DURATION

< 6 hours	1
-----------	---



landslide events impacting an area of a few square feet are likely. Therefore, the MPA team assigned the spatial extent for landslides a PRI value of 1.

Warning Time

Producing geological models and maps of areas vulnerable to landslides can assist with predicting if a landslide is likely to occur. However, the North Carolina Geological Survey has not produced a detailed landslide hazard map for Mecklenburg County because this area lacks the high slopes and history of landslides that would make it vulnerable to this hazard. Because these warning maps do not exist, and Davidson could potentially experience a minor landslide event caused spontaneously by a large amount of rainfall or human activity, the MPA team assigned warning time a PRI value of 2.

Duration

Recovery from a landslide can range from minutes to years (Highland and Bobrowsky, 2008). Considering that Davidson is likely to experience only minor landslide events the MPA team assigned duration a PRI value of 1.



VULNERABLE SITES

Davidson is bounded by the Town of Cornelius and the Town of Huntersville to the south, Cabarrus County to the east, Iredell County to the north, and Lake Norman to the west. Several branches of the Rocky River intersect the town.

Davidson contains several areas of particular relevance, including I-77, which intersects the far west portion of Davidson running north to south; Davidson College, which covers 665 acres and includes academic and administrative buildings, residence and dining halls, and athletic and performance venues; the Pines at Davidson, a retirement community located in West Davidson that spans over 100 acres; and MSC and Ingersoll Rand, two major employers that are located in the west portion of the town.

The west section of Davidson contains the majority of Davidson's non-residential development. Main Street runs north-south through the west side of the city. Several shops, restaurants, and public buildings are located in a centralized location on Main Street, including Town Hall, the Fire and Police Department, the Library, and the Post Office. Davidson has five K-12 schools that are located inside the city limits in the west side of the town. The east section of Davidson is primarily residential with some non-residential development.

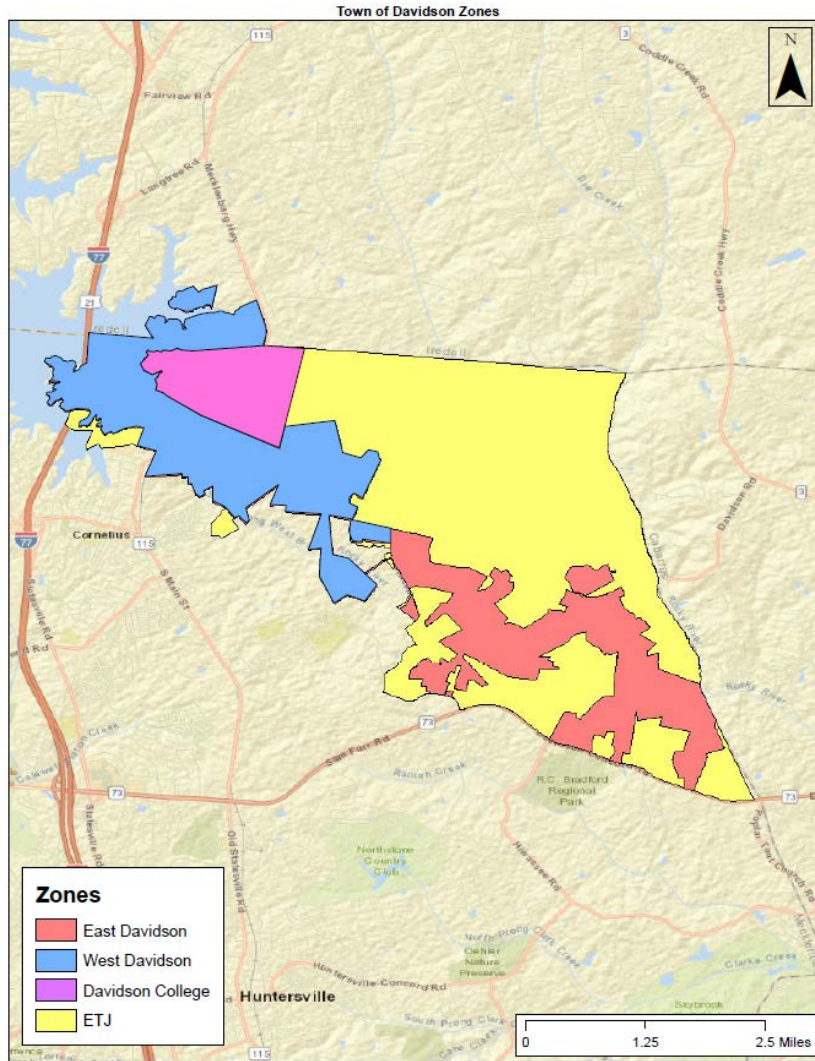
The ETJ consists primarily of rural space with some low-density residential development. While the ETJ has few working farms, it has several hobby farms and equine establishments.

Zones

To best identify target hazards, the MPA team divided Davidson into four zones: West Davidson, East Davidson, ETJ, and Davidson College, as seen in Figure 5.1. Due to their large spatial extent, certain hazards, including nuclear reactor failure, hurricanes/tropical storms, and earthquakes, would affect the entirety of the town should they occur. Each of the four zones, however, may have a heightened likelihood of experiencing impacts from some of the other hazard. This section identifies these hazards for each zone.



Figure 5.1
Town of Davidson Zones



Source: MPA Team

Zone 1: West Davidson

Characteristics

West Davidson contains five subzones: Davidson-West, The Pines, Williams Place, Davidson Pointe, and I-77.

Davidson-West is adjacent to two gas transmission pipelines and contains residential areas and five K-12 schools. It also includes a few affordable housing units for low-income residents, residents with mental or physical disabilities, and veterans; the units include *The Bungalows*, *The Cottages on Jetton*, and *Creekside Corner* respectively.

Davidson-West is also the location of Downtown Davidson. Downtown Davidson is home to Town Hall, several businesses and restaurants, and a gathering place for several major community events. It



also contains two of the Town's IT servers that provide support for daily public and private sector operations within its boundary. One is located at Town Hall, and the other at Nucentric Solutions, a computer support firm near the heart of the downtown area.

The Pines and Williams Place are retirement homes and assisted living units located in the southwestern portion of Zone 1. They house a special population of elderly residents and others requiring assisted living.

Also of importance is Davidson Pointe, a residential area that contains several townhomes, and Ingersoll Rand, the Town's largest employer. Ingersoll Rand produces non-acute hazardous waste, but in quantities of less than 220 pounds per month. A small electrical substation is also near Downtown Davidson that consists of one primary electrical line.

I-77 runs through the northeastern section of this zone and serves as a major transportation route for the entirety of the state. It is east of two of the Town's five gas transmission pipelines.

Risks

- Winter storms/hailstorms: The special populations that reside within this zone would experience severe impacts from a winter/hail storm due to the power outages that these storms can cause.
- Disease outbreak: A disease outbreak could significantly impact special populations due to their age and/or health.
- Sinkholes: Sinkholes would be more likely to occur in the downtown area or I-77 due to the amount of traffic and construction that they experience.
- Hazardous material spills: The presence of I-77 elevates the risk of a hazardous materials transportation incident. As a major thoroughfare, trucks carrying hazardous materials could crash on I-77, spilling their contents.
- Terrorism: Downtown Davidson, which is the location of several municipal services, IT servers, and community events, would be at an elevated risk for a terrorist attack. Though the likelihood of occurrence is small, the downtown area holds the kind of symbolic and/or practical significance that a terrorist might want to target.

Zone 2: East Davidson

Characteristics

East Davidson is largely residential with some commercial development. The south fork of the Rocky River runs through East Davidson, and a gas transmission pipeline intersects a portion of East Davidson.

Risks

- Flooding: Due to the location of the Rocky River, flooding is one hazard of relevance to East Davidson. Additionally, one of Davidson's dams is located upstream of East Davidson. If dam failure were to occur, the areas within East Davidson's floodplains may experience negative impacts.



- Hazardous material spills: East Davidson is also at an elevated risk for hazardous spills due to the presence of the gas transmission pipeline. However, if a pipeline incident were to occur, it would only affect the part of East Davidson directly above the pipeline.

Zone 3: Davidson College

Characteristics

Davidson College enrolls 1,950 students, with the majority living on campus. The main campus has 665 acres of land, housing several academic buildings, residence and dining halls, athletic and performance venues, and three of the Town's historic properties (Philanthropic Hall, Eumenean Hall, and Elm & Oak Row). It is also the site of the Cashion Power Substation and a major IT server. The substation provides the campus a more secure source of electricity through a direct connection to Duke Power's main transmission lines. Notably, the substation uses HyVolt II, a transformer oil that can be fatal if ingested or inhaled. The IT server, one of three within the town, provides support and functionality for computing processes.

Risks

- Terrorist attack or active shooter: Colleges and universities are attractive targets to terrorists and active shooters.
- Disease transmission: Because the student population lives in close quarters in the residence halls and work together closely in the other campus facilities, there is an increased risk of disease transmission.

Zone 4: ETJ

Characteristics

Davidson's ETJ is primarily rural, with some low-density development. The west branch of the Rocky River bisects the ETJ, and the main branch of the Rocky River bounds the ETJ on its east side. A gas transmission pipeline runs through a portion of the ETJ, and one dam is located in the middle of the ETJ on the west side of the west branch of the Rocky River.

Risks

- Drought and/or wildfire: Because of the large amount of rural area in the ETJ, a severe drought may cause dry vegetation in these areas, which may in turn increase the risk of wildfire.
- Dam failure and/or flooding: Flooding is a relevant concern, due to the location of the Rocky River and its tributaries. Additionally, flooding may occur in the ETJ due to dam failure.
- Hazardous material spills: The ETJ is at an elevated risk for experiencing negative impacts from hazardous spills due to the presence of the gas transmission pipeline. If a pipeline incident were to occur, it would only affect the locations within the ETJ that are directly above the pipeline.



CAPABILITY ASSESSMENT

Background

In addition to identifying regional vulnerabilities, the Risk Assessment conducted by Mecklenburg County in 2015 captured approaches to hazard mitigation in the county and its seven cities and towns. The resulting Capability Assessment evaluated and scored each municipality's ability to respond to the hazards acknowledged in the 2015 Risk Assessment. As part of the evaluation, Davidson provided information on several "capability indicators" related to its hazard vulnerability. This information included a catalog of local plans, policies, and ordinances; details about fiscal, administrative, and technical capacity; and a review of education and outreach programming (AECOM, 2015).

To measure Davidson's ability to respond to these and other community hazards, Mecklenburg County assigned a point value to each of the indicators included in the 2015 Capability Assessment. The County determined a town receiving anywhere from 56 to 103 points to be highly capable overall. In 2015, Davidson received a capability score of 67, indicating a high capacity to mitigate vulnerabilities (AECOM, 2015).

Overview of current resources

The MPA team collaborated with key stakeholders to specify in what ways Davidson has improved its hazard mitigation resource base since 2015.

Relevant plans, ordinances, and programs

Davidson moderates the degree of risk associated with identified community vulnerabilities by guiding and managing its growth with strategic plans and ordinances. Maintaining its commitment to a relevant growth strategy, the town has modernized several of its policies since 2015. First, the town's Economic Development Plan received extensive updates, as did its Rural Area Plan. Next, select ordinances (like the Capital Improvements Plan, Zoning Ordinance, Subdivision Ordinance, and Unified Development Ordinance) experienced annual modifications. Finally, the town will significantly improve its Mobility Plan and Comprehensive Land Use Plan in fiscal year 2018. The result of these updates is an increased ability to mitigate potential community hazards.

Table 8.11., located in Appendix L, provides a visual for the changes in plans, ordinances, and programs in Davidson since 2015.

Relevant staff/personnel resources

Hazard mitigation procedures are carried out by key personnel such as planners, engineers, and department heads. In 2015, Davidson proved its commitment to allocating human capital towards hazard mitigation, filling all but two positions identified by Mecklenburg County as relevant staff resources. The number of staff has not changed since 2015. Table 8.12., located in Appendix L, lists Davidson's active staff and personnel resources in 2017.



Fiscal Capability

Funding hazard mitigation procedures decreases the impact of a natural disaster or other event felt by the community. In 2015, Davidson supported risk reduction efforts by leveraging all but two funding sources identified as relevant by Mecklenburg County. Since 2015, all but one of these funding sources—Development Impact Fees—remains available to Davidson for hazard mitigation planning. Table 8.13., located in Appendix L, lists the fiscal resources available to Davidson in 2017.

Fire Department Capability

The Davidson Fire Department is responsible for fire protection, rescue services, and emergency medical aid. Since 2015, the Fire Department has expanded its capacity to respond to and adequately address emergency scenarios by increasing personnel, acquiring new amenities, and securing additional financial resources.

Personnel

The Fire Department has grown in size from 47 part-time staff in 2015 to a current roster of 57 part- and full-time employees. Of these, three are full-time driver/operators (D/Os) who cover one seated position across three different shifts. The remaining 54 employees - 43 firefighters, 10 captains, and the Fire Chief, all work part-time. Since 2015, the role of Fire Chief has been converted from a volunteer position, which was elected by the members of the fire department, to a part-time position, appointed by the town manager.

In 2015, the Fire Department staffed one company, made up of a fire truck and four firefighters. Since 2015, the addition of one part-time Captain and one full-time Engineer has enabled the Fire Department to staff two companies of three firefighters each. Five of these firefighters are part-time personnel, and the sixth is a full-time D/O (a position that was added in January of 2017). Beginning in January of 2018, the Fire Department will add another full-time D/O for Station 2—a new building slated to open at the end of 2017. The addition of this D/O position will bring the total number of 24-hour staffed positions to seven.

Fiscal resources

The budget for the Fire Department has steadily increased each fiscal year. In 2015, the Department's budget was approximately \$860,000; in 2018, this number will grow to roughly \$1.5 million.

Other resources

A second fire station is scheduled to be completed in December 2017. In addition, while the Fire Department will maintain the same number of fire engines, two will be replaced with newer models. A new tanker will also be added to the fleet by mid-2018.

Other significant changes

The Fire Department has added a Student EMT Team which responds to calls on the Davidson College Campus on weekend nights. This reduces the call load for the Department's two companies.

With an increase in personnel, financial, and other resources, the Fire Department's capacity to respond quickly and efficiently to emergency events in Davidson and the ETJ has improved since 2015. This



capacity is further strengthened as the Fire Department maintains its relationship with mutual and automatic aid partners to comprehensively manage emergency incidents in Davidson.

Police Department Capability

In conjunction with the Fire Department, the Davidson Police Department is an integral component of the town's hazard mitigation strategy. Since 2015, the Police Department has developed its capacity to manage the community's vulnerabilities by growing its force, developing its procedures, and increasing its operating budget.

Personnel

The Police Department has benefited from the addition of a detective to its force. At present, the agency is working to fill three new positions.

Fiscal and other resources

Since 2015, the Police Department has acquired resources to improve response time. First, the agency's budget expanded to cover the cost of equipment purchases, uniforms, and staffing increases. Second, the Department has added vehicles to its fleet to accommodate changes in procedure. Having more police vehicles allows the Department to conduct crime scene investigations, a service once provided by the Charlotte-Mecklenburg Police Department.

The town is currently working with the Police Department to address the need for a new building.

Procedures

The Police Department is an accredited agency through the Commission on Accreditation for Law Enforcement (CALEA) and frequently updates its policies and procedures to remain in compliance with accreditation standards. In addition, the Department continuously reviews how its technological assets help police officers and detectives remain transparent and accountable to Davidson's citizens. For example, the Police Department was one of the first in Mecklenburg County to implement and deploy body-worn cameras.

Finally, the agency has entered into a regional agreement with the Huntersville and Cornelius Police Departments to create a Special Weapons and Tactics (SWAT) team. The goal of the SWAT team will be to reduce response times when waiting for assistance from other agencies in Mecklenburg County.

Linking the Capability Assessment with the Risk Assessment

The Risk Assessment conducted by the MPA team will serve as the foundation of Davidson's new Emergency Operations Plan. This plan should include proposed mitigation actions to link identified hazards with personnel, financial, and other resources within the town. Mitigation actions to consider in conjunction with this Risk Assessment include prevention measures, property protection, funding of emergency services, and public education and awareness.



SUMMARY AND CONCLUSION

The MPA team performed a risk assessment and analysis, identified vulnerable sites, and reviewed and updated Davidson's Capability Assessment conducted by Mecklenburg County in 2015.

Various qualitative and quantitative methods were used to conduct the risk analysis, and the identified hazards were prioritized in the following order:

- Nuclear reactor failures
- Winter storms
- Thunderstorms/hailstorms
- Fire
- Hurricanes/tropical storms
- Wildfires
- Tornadoes
- Hazardous materials: Pipeline incident
- Dam failures
- Drought/heat
- Hazardous materials: Transportation incidents
- Terrorism and active shooter events
- Flood
- Severe disease outbreak
- Sinkholes
- Earthquakes
- Landslides

It is important to note that limitations exist in measuring risk from the identified hazards on a four-tiered value system. Mainly, events that have a near-zero likelihood of occurring but could still pose considerable threat to the town if they do happen may receive very high rankings, whereas events that occur regularly but do not threaten severe, widespread, or long-term damage receive lower rankings.

To measure Davidson's ability to respond to these hazards, Mecklenburg County assigned a point value to each of the indicators included in the 2015 Capability Assessment. The County determined a town receiving anywhere from 56 to 103 points to be highly capable overall. In 2015, Davidson received a capability score of 67, indicating a high capacity to mitigate vulnerabilities (AECOM, 2015). Today, the consensus from town employees is that Davidson is more capable of responding to hazards now than it was in 2015. Updates to relevant plans and ordinances, as well as additional personnel in the Fire and Police Departments, could raise Davidson's capability score.

Davidson's hazard mitigation efforts will be strengthened in the future as it works to create a new Emergency Operations Plan, projected to be completed in 2018. As existing plans are continuously updated and improved, the town's capacity to manage vulnerabilities will also progress. This report provides a foundation for this work and for allocating resources towards reducing and managing the identified hazards.



The MPA team commends the Town of Davidson for seeking to identify, mitigate, and plan for potential hazards.



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Figure 8.1 Map of proposed Rural Area Plan, Town of Davidson Rural Area Plan, www.ci.davidson.nc.us/1040/Rural-Area-Plan

Table 8.3 INES Scale for Nuclear and Radiological Events, International Nuclear Energy Agency, <https://www.iaea.org/sites/default/files/ines.pdf>

Table 8.4 US Nuclear Regulatory Commission Emergency Classifications, www.nrc.gov/about-nrc/emerg-preparedness

Table 8.5. Winter Weather - Winter Storm Database, State Climate Office of North Carolina, climate.ncsu.edu/climate/winter_wx/database.php

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Table 8.6: Town of Davidson Fire Incident Reports from 2009-2016, Davidson Fire Department Incident Data

Table 8.7: CP Safety Data Sheets, Colonial Pipeline Co., www.colpipe.com/docs/default-source/msds/sds-gasoline-english__us_.pdf?sfvrsn=2; Piedmont Natural Gas, www.piedmontng.com/files/pdfs/safety/safety-data-sheet.pdf; Williams, Inc., williamscom2014.files.wordpress.com/2017/08/natural_gasoline_sds-update-2-6-2017.pdf

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Appendix A

Table 8.1: High Risk Population Estimates for Davidson

Total Population 11,765		
	Number of People	Percentage of Population
<5 years old	526	4.5%
>64 years old	1316	11.2%
People in poverty	576	5.7%
Children >5 in poverty	55	0.5%
People with disabilities	754	6.5%
People with disabilities >64 years old	280	2.4%

Source: U.S. Census Bureau (2010)

Table 8.2: Town of Davidson Household Social Characteristics

2015 Estimated Occupied Households: 3,950		
	Number of Households	Percentage of Total Households
Family Households	2,670	67.6%
2 ≤ People Living in Home	2,864	72.5%
Married Couples Household	2,121	53.7%
Single Parent Household	549	13.9%
People Living Alone	1,086	27.5%
Adults Over 65 Living Alone	363	9.2%

Source: US Census Bureau, factfinder.census.gov

Appendix B

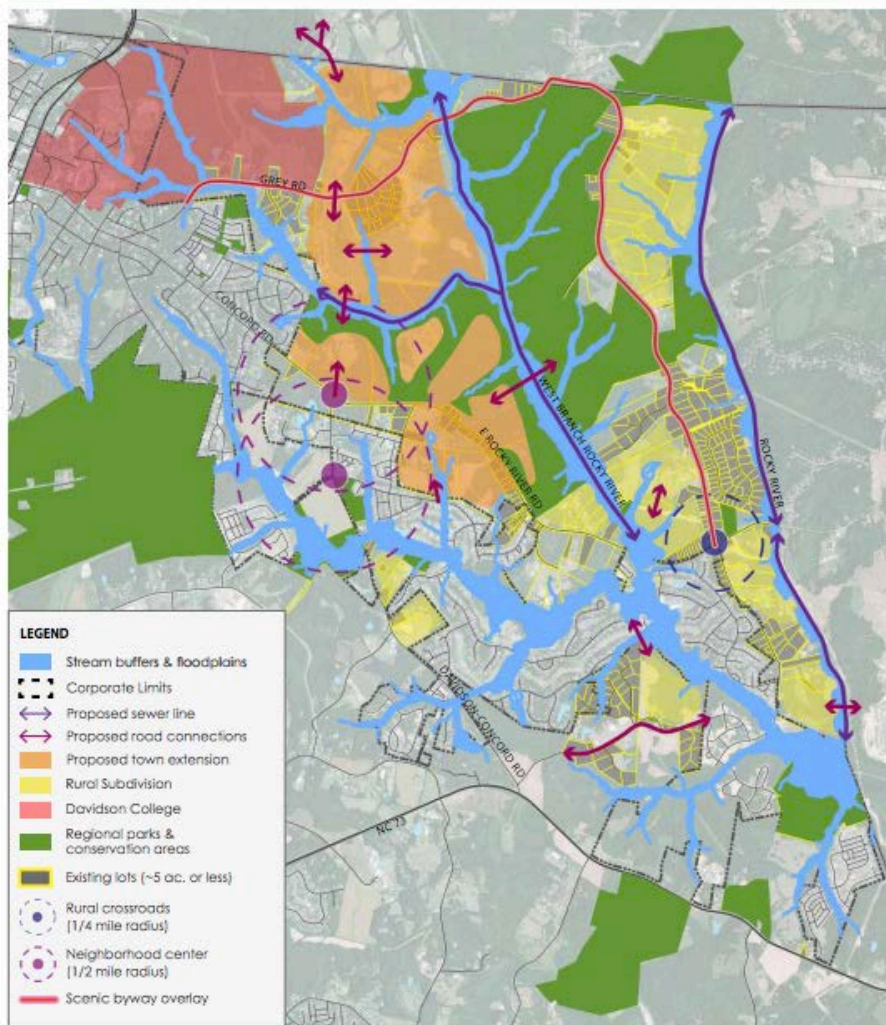
Growth Plan and Future Land Use

Comprehensive Plan Themes

- Create diverse business and job opportunities
- Support safe and vibrant public spaces and neighborhoods
- Promote cultural, socioeconomic and age diversity
- Encourage committed civic involvement and responsibility
- Provide sustainable and healthy choices for transportation, food and energy use
- Enable faithful stewardship of the natural and historic resources
- Continue to provide effective and efficient public services
- Maintain quality design and sound planning

Figure 8.1: Map of the proposed Rural Area Plan

MAP 6.1 DEVELOPMENT FRAMEWORK



Source: Town of Davidson Rural Area Plan (2016)



Appendix C

Table 8.3: INES Scale for Nuclear and Radiological Events

GENERAL DESCRIPTION OF INES LEVELS			
INES Level	People and Environment	Radiological Barriers and Control	Defence-in-Depth
Major Accident Level 7	<ul style="list-style-type: none"> Major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended countermeasures. 		
Serious Accident Level 6	<ul style="list-style-type: none"> Significant release of radioactive material likely to require implementation of planned countermeasures. 		
Accident with Wider Consequences Level 5	<ul style="list-style-type: none"> Limited release of radioactive material likely to require implementation of some planned countermeasures. Several deaths from radiation. 	<ul style="list-style-type: none"> Severe damage to reactor core. Release of large quantities of radioactive material within an installation with a high probability of significant public exposure. This could arise from a major criticality accident or fire. 	
Accident with Local Consequences Level 4	<ul style="list-style-type: none"> Minor release of radioactive material unlikely to result in implementation of planned countermeasures other than local food controls. At least one death from radiation. 	<ul style="list-style-type: none"> Fuel melt or damage to fuel resulting in more than 0.1% release of core inventory. Release of significant quantities of radioactive material within an installation with a high probability of significant public exposure. 	
Serious Incident Level 3	<ul style="list-style-type: none"> Exposure in excess of ten times the statutory annual limit for workers. Non-lethal deterministic health effect (e.g., burns) from radiation. 	<ul style="list-style-type: none"> Exposure rates of more than 1 Sv/h in an operating area. Severe contamination in an area not expected by design, with a low probability of significant public exposure. 	<ul style="list-style-type: none"> Near accident at a nuclear power plant with no safety provisions remaining. Lost or stolen highly radioactive sealed source. Misdelivered highly radioactive sealed source without adequate procedures in place to handle it.
Incident Level 2	<ul style="list-style-type: none"> Exposure of a member of the public in excess of 10 mSv. Exposure of a worker in excess of the statutory annual limits. 	<ul style="list-style-type: none"> Radiation levels in an operating area of more than 50 mSv/h. Significant contamination within the facility into an area not expected by design. 	<ul style="list-style-type: none"> Significant failures in safety provisions but with no actual consequences. Found highly radioactive sealed orphan source, device or transport package with safety provisions intact. Inadequate packaging of a highly radioactive sealed source.
Anomaly Level 1			<ul style="list-style-type: none"> Overexposure of a member of the public in excess of statutory annual limits. Minor problems with safety components with significant defence-in-depth remaining. Low activity lost or stolen radioactive source, device or transport package.
NO SAFETY SIGNIFICANCE (Below Scale/Level 0)			

Source: International Atomic Energy Agency



Appendix D

Table 8.4: US Nuclear Regulatory Commission Emergency Classifications

Emergency Classification	Description	Purpose
Notification of Unusual Event (NOUE)	Events are in progress or have occurred which indicate a potential degradation of the level of safety of the plant or indicate a security threat to facility protection has been initiated. No releases of radioactive material requiring offsite response or monitoring are expected unless further degradation of safety systems occurs.	To assure that the first step in future response has been carried out, to bring the operations staff to a state of readiness, and to provide systematic handling of unusual event information and decision-making.
Alert	Events are in progress or have occurred which involve an actual or potential substantial degradation of the level of safety of the plant or a security event that involves probable life-threatening risk to site personnel or damage to site equipment because of HOSTILE ACTION. Any releases are expected to be limited to small fractions of the Environmental Protection Agency	To assure that emergency personnel are readily available to respond if the situation becomes more serious or to perform confirmatory radiation monitoring if required, and provide offsite authorities current information on plant status and parameters.
Site Area Emergency (SAE)	Events are in progress or have occurred which involve actual or likely major failures of plant functions needed for protection of the public or hostile action that results in intentional damage or malicious acts; 1) toward site personnel or equipment that could lead to the likely failure of or; 2) that prevent effective access to, equipment needed for the protection of the public. Any releases are not expected to result in exposure levels which exceed EPA PAG exposure levels beyond the site boundary.	To assure that emergency response centers are staffed, to assure that monitoring teams are dispatched, to assure that personnel required for evacuation of near-site areas are at duty stations if the situation becomes more serious, to provide consultation with offsite authorities, and to provide updates to the public through government authorities.
General Emergency	Events are in progress or have occurred which involve actual or imminent substantial core degradation or melting with potential for loss of containment integrity or hostile action that results in an actual loss of physical control of the facility. Releases can be reasonably expected to exceed EPA PAG exposure levels offsite for more than the immediate site area.	To initiate predetermined protective actions for the public, to provide continuous assessment of information from the licensee and offsite organizational measurements, to initiate additional measures as indicated by actual or potential releases, to provide consultation with offsite authorities, and to provide updates for the public through government authorities

Source: US Nuclear Regulatory Commission



Appendix E

Table 8.5: Winter storm related precipitation in the past 15 years, Concord Weather Station

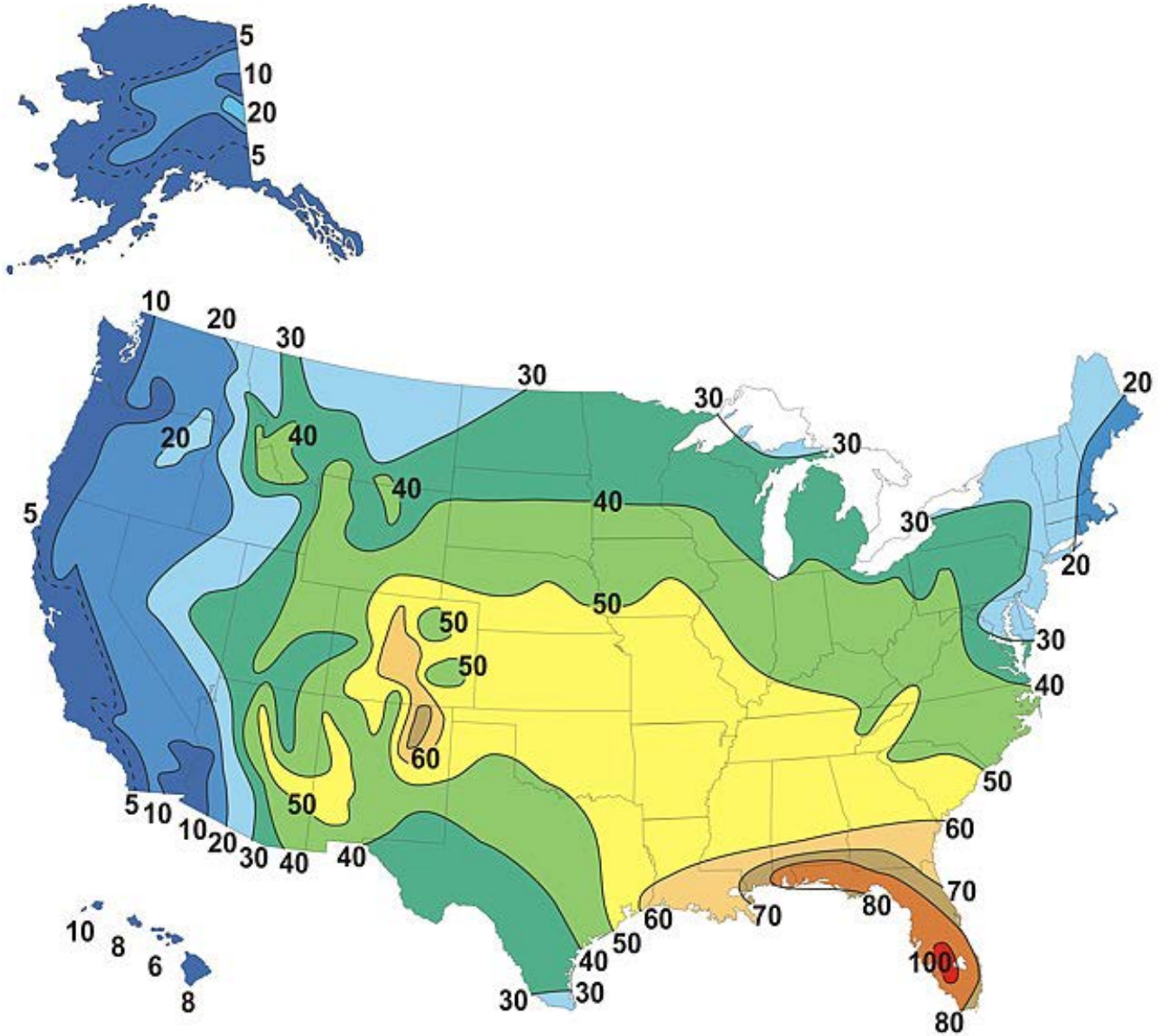
Date	Precipitation Type	Date	Precipitation Type
1/2/2002	Snow; Sleet	2/15/2010	Snow
2/8/2002	Black Ice	3/2/2010	Snow; Heavy Snow
12/4/2002	Snow; Sleet; Freezing Rain	12/4/2010	Snow
1/16/2003	Snow	12/15/2010	Snow; Freezing Rain
1/22/2003	Snow; Cold	12/25/2010	Snow; Heavy Snow
2/15/2003	Snow; Sleet; Freezing Rain	1/10/2011	Snow; Freezing Rain
12/4/2003	Snow; Sleet; Freezing Rain	2/9/2011	Snow; Rain
1/9/2004	Snow	2/19/2012	Snow; Sleet; Rain
1/25/2004	Snow; Sleet; Freezing Rain	1/17/2013	Snow
2/26/2004	Heavy Snow; Sleet	2/16/2013	Snow
1/29/2005	Snow; Sleet	11/25/2013	Snow; Freezing Rain
12/15/2005	Freezing Rain; Sleet; Ice	1/28/2014	Snow; Sleet; Freezing Rain
3/20/2006	Freezing Rain; Sleet	2/11/2014	Snow; Freezing Rain
10/14/2006	Frost; Freeze	2/12/2014	Snow; Sleet; Freezing Rain
12/8/2006	Frost; Freeze	3/6/2014	Snow; Sleet; Freezing Rain
1/21/2007	Rain; Freezing Rain	3/17/2014	Snow; Freezing Rain
2/1/2007	Snow	2/16/2015	Snow
1/17/2008	Snow	2/18/2015	Snow
1/19/2008	Snow	2/23/2015	Snow; Freezing Rain
1/19/2008	Snow; Heavy Snow	2/25/2015	Snow; Sleet; Freezing Rain
2/3/2009	Snow	1/17/2016	Snow; Cold
3/1/2009	Snow	1/22/2016	Snow; Sleet; Freezing Rain; Wind
12/18/2009	Snow; Heavy Snow	2/14/2016	Snow; Sleet; Freezing Rain; Cold
1/29/2010	Heavy Snow; Sleet; Freezing Rain	1/6/2017	Snow; Sleet; Freezing Rain
2/4/2010	Heavy Snow; Freezing Rain	3/11/2017	Snow
2/12/2010	Snow; Heavy Snow		

Source: State Climate Office Of North Carolina



Appendix F

Figure 8.2: Annual Average Number of Thunderstorm Days



Source: State Climate Office of North Carolina



Appendix G

Town of Davidson Fire Incident Reports from 2009-2016

Type of Incident	2009	2010	2011	2012	2013	2014	2015	2016	Total Number of Incidents
Structure Fire	54	22	29	27	25	24	24	28	233
Fire in Mobile Property (Fixed Structure)	0	0	0	0	0	0	0	0	0
Mobile Property	5	7	3	4	6	5	5	3	38
Other	0	6	1	2	2	1	2	2	16

Source: Davidson Incident Data



Appendix H

Table 8.7: Hazard level of transported commodities in Davidson

Company Name	Transported Commodity	NFPA 704 Hazard Class	Hazard Level (as defined by NFPA 704)
Piedmont Natural Gas Co.	Natural gas		<p>Flammability Hazard=4 (Extreme: Extremely flammable gas or liquid)</p> <p>Health=1 (Slight: Breathing apparatus may be worn)</p> <p>Instability Hazard=0 (Minimal: Normally stable. Does not react with water)</p>
Williams	Natural gas		<p>Flammability Hazard=4 (Extreme: Extremely flammable gas or liquid)</p> <p>Health=2 (Moderate: Breathing apparatus and face mask must be worn)</p> <p>Instability Hazard=0 (Minimal: Normally stable. Does not react with water)</p>
Colonial Pipeline Co.	Hazardous liquid		<p>Flammability Hazard=4 (Extreme: Extremely flammable gas or liquid)</p> <p>Health=1 (Slight: Breathing apparatus may be worn)</p> <p>Instability Hazard=0 (Minimal: Normally stable. Does not react with water)</p>

Source: Piedmont Natural Gas, Williams, and Colonial Pipeline Co.



Appendix I

Terrorism and Active Shooter Events in North Carolina

March 3, 2006, Chapel Hill, NC

Mohammed Reza Taheri-azar rented a Jeep Cherokee and drove it through a crowd of people gathered in "The Pit" on the University of North Carolina- Chapel Hill campus injuring nine people. His intention was to hurt or kill people to in response to Muslim deaths that had occurred worldwide (National Consortium for the Study of Terrorism (START), 2016).

August 24, 2006, Hillsborough, NC

Alvaro Castillo, 19, initiated an active shooter event at his former school, Orange High School, after fatally shooting his father early that morning. Although he was armed with two pipe bombs, two rifles, a shotgun, and a smoke grenade, police apprehended him. One person died, and two were injured (Federal Bureau of Investigation, 2017).

April 7, 2009, Carthage, NC

Robert Kenneth Stuart, 45, opened fire at the Pinelake Health and Rehabilitation Center while attempting to find his estranged wife. Armed with a handgun, a shotgun, and a rifle, Stuart killed eight people and wounded three, including a police officer, prior to capture (Federal Bureau of Investigation, 2017).

January 12, 2012, Star, NC

Ronald Dean Davis, 50, used a shotgun to shoot at his co-workers at McBride Lumber Company. He killed three people and wounded one before turning the gun on himself (Federal Bureau of Investigation, 2017).

March 23, 2012, Durham, NC

O'Brian McNeil White, 24, used a handgun to initiate an active shooter event at the J.T. Tire Store. He killed two people and injured two before fleeing the scene. Police arrested him one week later (Federal Bureau of Investigation, 2017).

May 26, 2013, Jacksonville, NC

Esteban Jimenez Smith, 23, fatally shot his wife in North Carolina before continuing on to Brady, Texas where he killed another person and injured five more (including an officer). The police shot and killed Smith (Federal Bureau of Investigation, 2017).

June 21, 2013 Greenville, NC

Lakin Anthony Faust, 23 initiated an active shooting event Kellum Law Firm and an adjacent Walmart parking lot. Although there were no deaths, the shooter injured four people prior to police taking him into custody (Federal Bureau of Investigation, 2017).



December 18, 2014, Morganton, NC

Justin Nojan Sullivan robbed and killed John Bailey Clark Jr. Sullivan planned to use the money he stole from Clark Jr. to purchase a rifle to use in an Islamic State of Iraq and the Levant (ISIL) inspired attack (National Consortium for the Study of Terrorism (START), 2016).

June 24, 2015, Charlotte, NC

An unknown number of assailants set fire to Briar Creek Baptist Church in Charlotte. There were no reported casualties in the attack (National Consortium for the Study of Terrorism (START), 2016).



Appendix J

Impacts of Biological, Nuclear, Radiological, and Chemical Terrorist Attacks

A biological attack, one that uses a disease agent, could result in a life-threatening illness for humans or animals (National Academies & U.S. Department of Homeland Security, 2004a). An actor could also target the food supply with a disease agent, causing economic damage and a loss of confidence in the food supply (National Academies & U.S. Department of Homeland Security, 2004a).

A nuclear attack, which uses a device that produces a nuclear explosion, can cause significant radiological consequences from both the initial nuclear radiation and the resulting radioactive fallout (National Academies & U.S. Department of Homeland Security, 2005). An electromagnetic pulse from the explosion could also disrupt telecommunications and power distribution (National Academies & U.S. Department of Homeland Security, 2005).

Radiological attacks differ from nuclear attacks in that the actor uses a weapon, such as a dirty bomb, to disperse radioactive irritants and materials that cause injury upon detonation. Because these weapons rarely deliver the amount of material needed to cause immediate harm, actors most often use them to contaminate facilities or places where people live and work (National Academies & U.S. Department of Homeland Security, 2004c). This can disrupt lives and cause anxiety in those who believe they have been exposed (National Academies & U.S. Department of Homeland Security, 2004c).

Impacts resulting from a chemical attack can vary depending on their degree of toxicity, the concentration of the chemical, the route of exposure, and the duration of the exposure (National Academies & U.S. Department of Homeland Security, 2004b). They can cause sickness when absorbed into the body, and disrupt daily life if the area must be decontaminated (National Academies & U.S. Department of Homeland Security, 2004b).



Appendix K

Table 8.8: Fatal and nonfatal crashes involving hazardous materials in the United States, 2015

HM Cargo Type	HM Release							
	Yes		No		Unknown		Total	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Fatal Crashes								
Explosives	2	6.1%	2	2.3%	0	0%	4	3%
Gases	3	9.1%	14	19.3%	0	0%	20	14.9%
Flammable Liquids	22	66.7%	51	58%	4	30.8%	77	57.5%
Flammable Solids	0	0%	0	0%	1	7.7%	1	.7%
Oxidizing Substances	0	0%	1	1.1%	0	0%	1	.7%
Poisonous and Infectious Substances	0	0%	0	0%	0	0%	0	0%
Radioactive Materials	0	0%	0	0%	0	0%	0	0%
Corrosives	2	6.1%	6	6.8%	1	7.7%	9	6.7%
Miscellaneous Dangerous Goods	0	0%	2	2.3%	0	0%	2	1.5%
Unknown	4	12.1%	9	10.2%	7	53.8%	20	14.9%
Total	33	100%	88	100%	13	100%	134	100%
Nonfatal crashes								
Explosives	11	2.4%	91	3.6%	22	3.9%	124	3.5%
Gases	61	13.3%	434	17.1%	66	11.7%	561	15.8%
Flammable Liquids	250	54.7%	1,231	48.6%	340	60.5%	1,821	51.3%
Flammable Solids	6	1.3%	24	.9%	9	1.6%	39	1.1%
Oxidizing Substances	8	1.8%	24	.9%	13	2.3%	45	1.3%
Poisonous and Infectious Substances	4	.9%	20	.8%	4	.7%	28	.8%
Radioactive Materials	0	0%	4	.2%	0	0%	4	.1%
Corrosives	40	8.8%	203	8.1%	53	9.4%	299	8.4%
Miscellaneous Dangerous Goods	25	5.5%	212	8.4%	21	3.7%	258	7.3%
Unknown	52	11.4%	285	11.3%	34	6%	371	10.5%
Total	457	100%	2,531	100%	562	100%	3,550	100%
OVERALL TOTAL	490		2,619		575		3,684	

Source: Federal Motor Carrier Safety Administration



Appendix L

Table 8.11: Capability Assessment, Davidson

Plan Title	Included in 2015 CA?	Updated since 2015? (Date updated?)	Owner of plan (person or department)
Hazard Mitigation Plan	X		Mecklenburg County
Comprehensive Land Use Plan	X	Comprehensive update scheduled for FY '18	Planning Dept
Floodplain Management Plan	X		
Open Space Management Plan	X	X (updated as the Rural Area Plan)	Planning Dept
Stormwater Management Plan	X		Planning Dept and Public Works Director
Emergency Operations Plan	X		PIO/Police and Fire Depts
SARA Title III Plan	X		Mecklenburg County
Radiological Emergency Plan	X		Mecklenburg County
Continuity of Operations Plan	X		
Evacuation Plan	X	X	Duke Energy
Disaster Recovery Plan	X		
Capital Improvements Plan	X	X (updated every year)	
Economic Development Plan	X	X	Economic Dev Mgr
Historic Preservation Plan	X		Planning Dept
Transportation Plan	X	Mobility Plan slated to begin in FY '18	Planning Dept
Flood Damage Prevention Ordinance	X		
Zoning Ordinance	X	Ongoing updates	Planning Dept
Subdivision Ordinance	X	Ongoing updates	Planning Dept
Site Plan Review Requirements	X	Ongoing updates	Planning Dept
Unified Development Ordinance	X	Ongoing updates	Planning Dept
Post-disaster Redevelopment/Recovery Ordinance	X		
Building Code	X		Mecklenburg County
Fire Code	X		Mecklenburg County



Community Wildfire Protection Plan	
NFIP	X
NFIP Community Rating System	

Source: Dawn Blobaum, Assistant Town Manager, Town of Davidson

Table 8.12: Capability Assessment Position Titles, Davidson

Position title/Resource name	Filled/existed in 2015?	Current employee(s) in title/resource still active/resource activated:
Planners with knowledge of land development and land management practices	X	5 planners
Engineers or professionals trained in construction practices related to buildings and/or infrastructure	X	Public Works Director
Planners or engineers with an understanding of natural and/or human-caused hazards	X	
Building Official		Mecklenburg County
Emergency manager	X	Town Manager
Floodplain manager	X	Mecklenburg County
Land surveyors		
Scientist familiar with the hazards of the community		
Staff with education or expertise to assess the community's vulnerability to hazards	X	Fire Dept
Personnel skilled in Geographic Information Systems (GIS) and/or HAZUS	X	Planning Dept
Resource development staff or grant writers	X	
Maintenance programs to reduce risk	X	Human Resources Mgr
Warning systems/services	X	
Mutual Aid Agreements	X	Police and Fire Depts

Source: Dawn Blobaum, Assistant Town Manager, Town of Davidson



Table 8.13: Capability Assessment Resources, Davidson

Resource	Available in 2015?	Available today?	Significant changes in availability?
Capital Improvement Programming	X	X	No
Community Development Block Grants	X	X	No
Special Purpose Taxes	X	X	No
Gas/Electric Utility Fees			
Water/Sewer Fees			
Stormwater Utility Fees	X	X	No
Development Impact Fees	X		
General Obligation Bonds	X	X	No
Revenue Bonds	X	X	No
Special Tax Bonds	X	X	No

Source: Dawn Blobaum, Assistant Town Manager, Town of Davidson