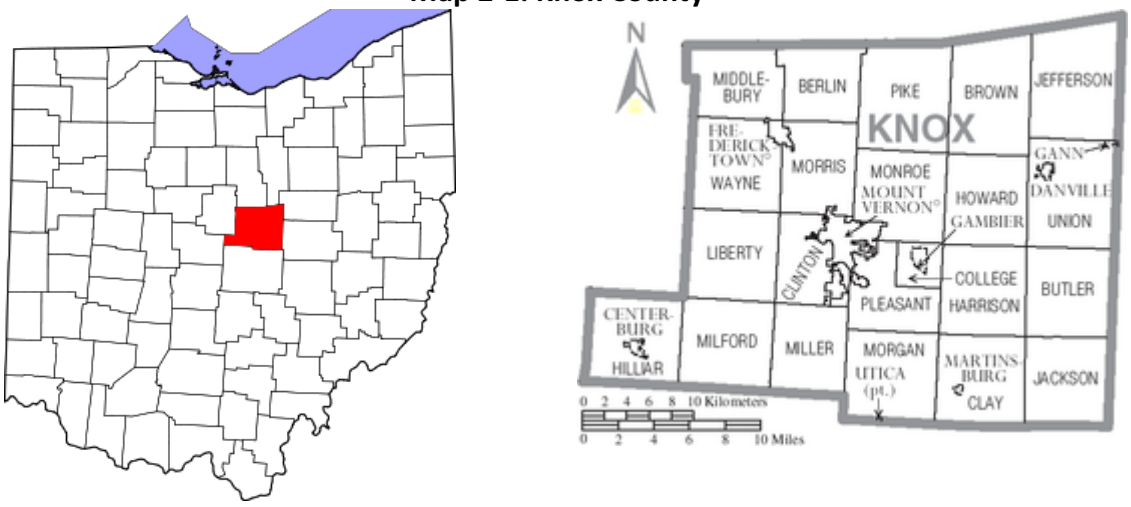
2.0 HAZARD IDENTIFICATION AND RISK ASSESSMENT

The Hazard Identification and Risk Assessment (HIRA) addresses the type and frequency of disasters that affect Knox County and the risk to people and property. The HIRA is addressed in four sections. The County Profile provides general information about Knox County and its jurisdictions. The Hazard Identification section describes hazards that impact Knox County; the Vulnerability Assessment discusses each jurisdiction's vulnerability to the identified hazards and the Risk Analysis evaluates and ranks the hazards Knox County intends to address through mitigation efforts.

2.1 COUNTY PROFILE

Knox County is located in central Ohio; it is a rural county with a land area of 527.2 square miles. The county borders Richland, Ashland, Holmes, Coshocton, Licking, Delaware, and Morrow counties. Columbus, the state capital, is the closest major city and is approximately 50 miles to the southwest.

Map 2-1: Knox County



2.1.1 Demographics

According to US Census data, Knox County's estimated 2018 population is 61,893. The 2010 population was 60,921. The county's population has remained relatively steady, a trend that is expected to continue for the next several decades.

Table 2-1: Knox County Population Statistics

Statistic	Figure
Population Density	1015.9/sq. mile
Female Population	51.0%
Male Population	49.0%
Number of Households	23,229
Population under 18	22.7%
Population over 65	18.1%
White	96.6%
African-American	1.0%
Native American	0.1%
Asian	0.4%
Other	0.1%
Two or More Races	1.7%
Hispanic (of any race)	1.4%
Average Household Size	2.47 persons
Median Household Income	$51,211
Persons in Poverty	13.8%

Knox County has 25,648 housing units. The owner-occupied housing rate is 71.3%. The median value of owner-occupied units is $138,900. The median monthly cost for a home with a mortgage is $1,151. The county has 6,658 renter-occupied housing units, including approximately 1,191 mobile homes. The median gross rent for these rental units is $712 per month.

2.1.3 Incorporated Jurisdictions

Knox County has seven incorporated municipalities. Mount Vernon is the largest municipality and only city in the county. It serves as the county seat and is the primary business and retail center of the county.

The county has six incorporated villages. By definition, a village in Ohio has fewer than 5,000 residents. The village of Gann was previously incorporated under the name Brinkhaven. For clarity, the village is referred to as Gann/Brinkhaven throughout the mitigation plan.

Table 2-2: Municipal Demographics

City/Village	Population	Households	Median Income	Persons Below Poverty
Centerburg	2,214	760	$37,368	17.8%
Danville	1,014	591	$39,964	19.7%
Fredericktown	2,493	1,332	$42,222	12.2%
Gambier	2,458	495	$65,438	24.6%
Gann/Brinkhaven	121	73	$50,625	14.4%
Martinsburg	228	128	$41,518	10.6%
Mount Vernon	16,701	6,996	$41,098	21.9%

The village of Utica is partially located in Knox County. For mitigation planning purposes, they participate in the plan for Licking County and are not included in this plan.

2.1.4 Unincorporated Areas

The unincorporated area of Knox County is divided into 22 townships. In Ohio, townships are governed by an elected board of trustees. They meet at least once per month and are responsible for the safety and welfare of township residents. Townships also have elected Fiscal Officers who manage the township's finances. Because townships are unincorporated, they are considered part of the county for the purpose of hazard mitigation planning and activities.

Table 2-3: Township Population Statistics

Township	Population
Berlin	1,738
Brown	1,862
Butler	1,171
Clay	1,604
Clinton	2,826
College	2,731
Harrison	806
Hilliar	3,715
Howard	5,617
Jackson	988
Jefferson	633
Liberty	1,716
Middlebury	1,278
Milford	1,772
Miller	1,006
Monroe	2,165
Morgan	1,085
Morris	2,049
Pike	1,532
Pleasant	1,606
Union	2,646
Wayne	892

Unincorporated Communities

Knox County has 23 unincorporated communities and three census-designated places. These small neighborhoods are not organized municipalities and do not have any official form of government; they function as part of the township in which they are located. Most of these locations have historical significance or were incorporated in the past but have a population that has decreased to the point that they are no longer considered a municipality. Howard (Howard Township) and Bladensburg (Clay and Jackson Townships) are two of the larger census-designated places in the county.

Apple Valley is another unincorporated community of significant size. This community, located in Howard and Brown Townships, occupies approximately 3,770 acres surrounding Apple Valley Lake. Apple Valley Lake is a 511-acre man-made lake with 9.25 miles of shoreline. The community was formed in 1972 and is a mix of year-round and seasonal residences. According to 2010 U.S. Census figures, the population is 5,058, making it the second most populated community in Knox County.

2.1.5 Institutions and Special Facilities

Across Knox County, residents have access to abundant educational and healthcare resources. These services contribute to the quality of life and the successful development of the local economy.

Education

Students in Knox County are served by nine public school districts and several private schools. In the most rural areas of the county, several Amish schools also serve Knox County's significant Amish population.

Table 2-4: Knox County Schools

Public School Districts	Private/Parochial Schools
Centerburg Local School District	Christian Star Academy
Clear Fork Valley Local School District	Mount Vernon SDA Elementary School
Danville Local School District	St. Vincent De Paul School
East Knox Local School District	Temple Christian Academy
Fredericktown Local School District	
Knox County Career Center	
Loudonville-Perrysville Exempted Village School District	
Mount Vernon City School District	
North Fork Local School District	
Northridge Local School District	

The county is also home to several colleges and universities. Kenyon College, located in Gambier, is a private liberal arts college with approximately 1,700 students, all of whom live on campus. Mount Vernon Nazarene University is a private college offering undergraduate and graduate programs to approximately 2,200 students. Approximately 1,000 students live on campus. Central Ohio Technical College also operates a campus in Mount Vernon that provides associate degree, certificate, and career-technical programs.

Healthcare

Knox Community Hospital is the only hospital in Knox County. This 115-bed facility, located in Mount Vernon, offers a wide range of inpatient and outpatient services, included emergency care, intensive care, and a cancer center.

Residential healthcare facilities are present throughout Knox County. These facilities include eight licensed nursing homes with a total of 557 beds and five residential care facilities with a

total of 220 beds. These facilities provide healthcare and housing for elderly individuals, dementia patients, and others recovering from short- and long-term illnesses and injuries.

2.1.6 Infrastructure

Infrastructure and utility systems provide access and critical services to residents, workers, and visitors. This section describes the county's road and rail infrastructure, airports, and utility systems.

Transportation Systems

Knox County is traversed by more than 1,335 miles of roadways. Of these, 59 miles are U.S routes, 140 miles are state highways, and 1,136 miles are county, township, and municipal roadways. There are no interstate routes within the borders of Knox County but I-70, I-71, and I-77 are easily accessible from various highways and routes within the county. A complete list of federal and state highways in the county is provided in the table below.

Table 2-5: Knox County Highways

Interstates	U.S. Highways	State Highways	
None	US 36	SR 3	SR 514
	US 62	SR 13	SR 541
		SR 95	SR 586
		SR 205	SR 661
		SR 229	

Knox County's county road system includes 221 bridges with spans greater than twenty feet, 100 bridges that are ten to nineteen feet wide, and approximately 6,300 culverts. These numbers change as bridges are replaced.

Rail

With only one rail line present in the county. Knox County has very limited rail traffic.

Airports

Knox County has one public and two private airports. The Knox County Regional Airport, located four miles southwest of Mount Vernon, is the only public airport in Knox County.

Utilities

The majority of Knox County homes, approximately 53.1%, are heated with natural gas. An additional 20.1% utilize electric heat. The Public Utilities Commission of Ohio regulates private companies that provide public utility services. These companies, along with municipal electric utilities, are identified in table 2-6.

Table 2-6: Knox County Utility Providers

Electric Service	Natural Gas Service
AEP Ohio	Columbia Gas of Ohio
Consolidated Electric	Consumers Gas Cooperative
Licking Rural Electrification	Dominion East Ohio
Ohio Edison/First Energy	Knox Energy Cooperative Association Inc.
	Ohio Gas Company

The remaining structures in the county utilize alternate heat sources.

- Bottled, tank, or LP gas 14.4%
- Coal, coke or wood 7.2%
- Fuel oil, kerosene 3.1%
- Solar energy or other fuel 1.8%
- No fuel used 0.3%

Within most incorporated jurisdictions, water and wastewater services are provided by municipal systems that are maintained by the jurisdiction or utility company, such as Del-Co Water. Outside of the incorporated areas and in smaller jurisdictions, these services are generally provided by private wells and septic systems that are maintained by individual property owners.

2.1.7 Topography and Climate

Knox County's landscape features river valleys, rolling hills, pastures, and woodlands. This variation is due primarily to the continental glaciers that covered the region more than 15,000 years ago. The only exception to this is the easternmost portions of Jefferson, Union, and Butler Townships which feature deep valleys and steep hills.

Knox County's average elevation is 1,113 feet above sea level. Across the county, elevations range from a high point of 1,420 feet above sea level in Liberty Township to a low of 840 feet above sea level in Butler Township. The maximum difference in elevation between the high and low points is approximately 600 feet. The steepest slopes in the county are located in the northeast section near the Mohican River.

Climate

The humid continental climate of Knox County is consistent with most of Ohio and features cold winters and hot summers. The average annual temperature is 48.25° F. July is the warmest month with an average high temperature of 82° F. January is the coldest month with an average low temperature of 15° F. Average annual rainfall is 40.51 inches. May is typically the wettest month with average precipitation of 4.41 inches. February generally has the least precipitation with an average of 2.4 inches.

2.1.8 Waterways and Watershed

Knox County has three major rivers: Kokosing River, Mohican River, and North Fork of the Licking River. The Kokosing and Mohican Rivers have both been designated State Scenic Rivers by the Ohio Environmental Protection Agency.

Within the county, there are several man-made lakes that are used primarily for recreation and flood control. Kokosing Lake is the smallest at 160 acres. It was constructed in 1971 for flood control and recreation and is a dam-controlled lake maximizing at thirty feet deep. Knox Lake is a 500-acre, dam-controlled recreational lake that is 24 feet at its deepest area. Apple Valley Lake, the largest at 511 acres, is thirty feet deep and also controlled by a dam.

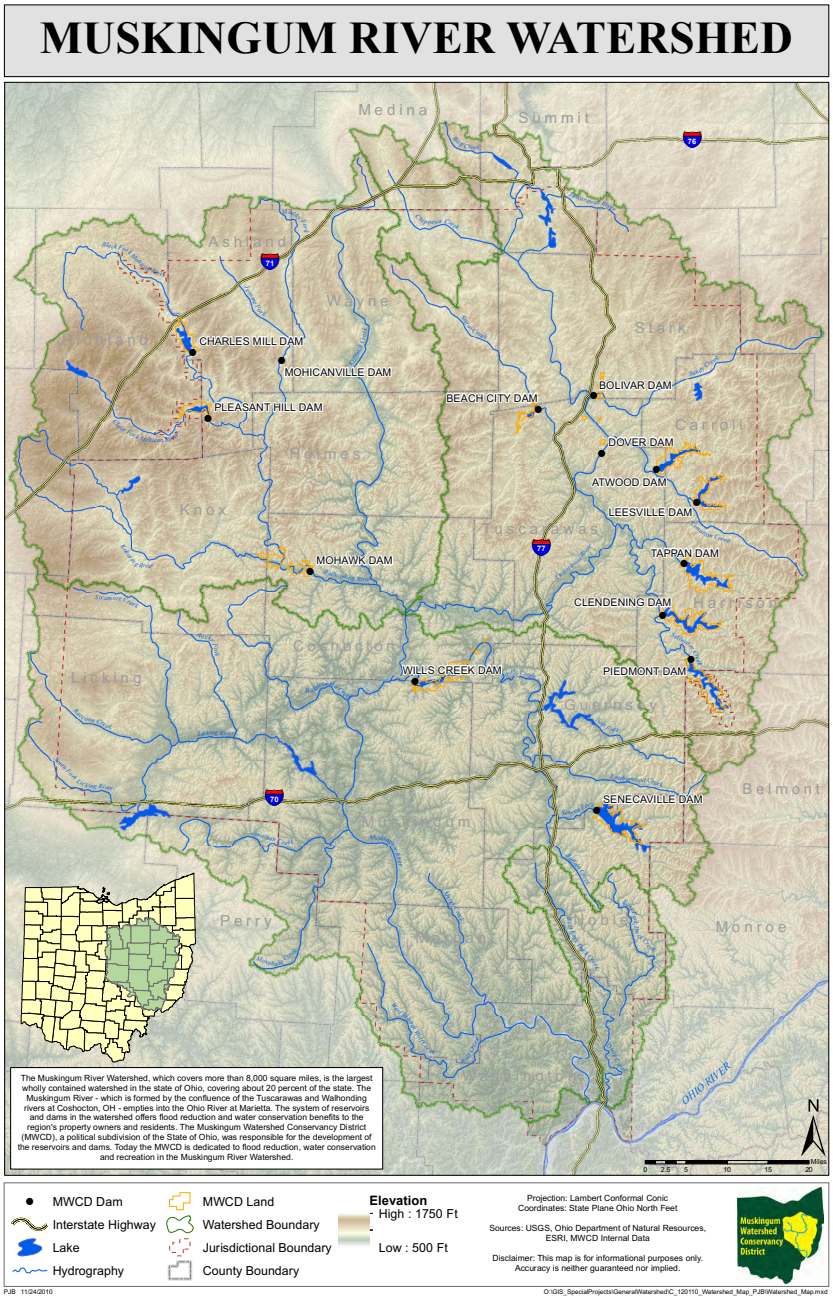
In addition to the rivers and lakes, Knox County has 851 miles of ditches and streams. Intermittent streams, defined as streams where water only flows during part of the year, account for 365 miles of waterway. Another 382 miles are considered perennial streams, meaning that water flows year-round during periods of normal rainfall.

Table 2-7: Knox County Waterways

Lakes	Streams and Creeks	
Apple Valley Lake	Adams Run Armstrong Run	Jug Run
Edward Smith Lake	Barney Run	Kokosing River
Knox Lake	Beach Run	Little Jelloway Creek
Kokosing Lake	Big Run	Little Schenck Creek
Lake Hiawatha	Brush Run	Lost Run
Lake Viering	Center Run	Markley Run
Little Lake	Chambers Creek Coleman Branch	Mile Run
	Curtis Run	Muckshaw Run
	Delano Run	Mud Run
	Dowd Creek	North Branch Kokosing River Owl
	Dry Creek	Creek Stream
	Dry Run	Pleasant Valley Run
	East Branch Jelloway Creek	Prairie Run
	East Branch Kokosing River East	Pumpkin Run
	Branch Rocky	Ransoms Run
	Fork Elliot Run	Sapps Run
	Flat Run	Schenck Creek
	Ford Creek	Shadley Valley Creek
	Granny Creek	South Run
	Harrod Run	Sycamore Creek
	Honey Run	Tomaky Branch
	Indianfield Run	Tuma Run
	Ireland Creek	Wakatomika Creek
	Isaacs Run	Webster Run
	Jelloway Creek	Wolf Run.
	Job Run	

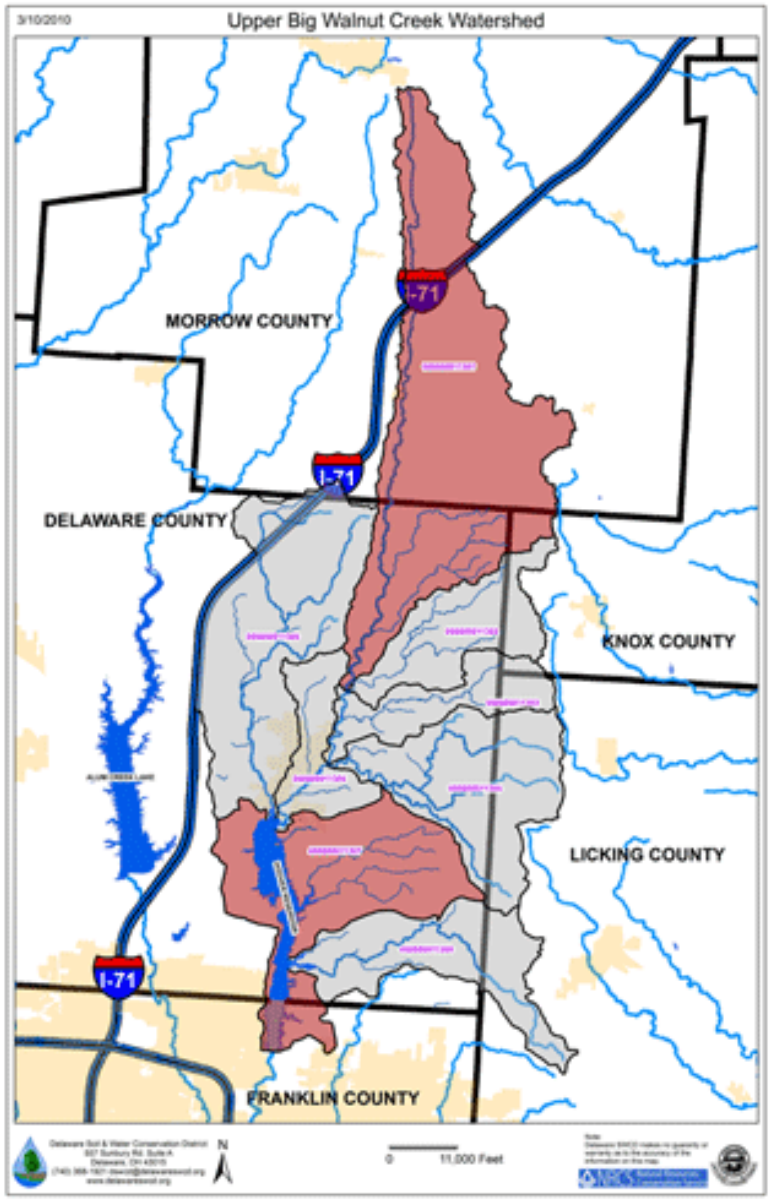
The majority of Knox County is part of the Muskingum River Watershed. This large watershed covers more than 8,000 square miles across all or part of 27 Ohio counties and encompasses more than 20% of Ohio. The watershed is divided into multiple sub-watersheds. Knox County is located in four of these sub-watersheds. The Kokosing River Watershed is the largest of these, encompassing most of the county. The upper northeast corner of the county falls in the Mohican River Watershed and the southwest section falls in the Licking River Watershed. The extreme southeast corner of the county, near Bladensburg, is located in the Wakatomika Creek Watershed.

Map 2-2: Muskingum River Watershed



The only area of Knox County that is not part of the Muskingum River Watershed is a small area on the western edge of the county, just west of Centerburg. This area is part of the Upper Big Walnut Creek Watershed, which is part of the Scioto River Watershed.

Map 2-3: Scioto River Watershed



2.1.9 Land Use

Cultivated crops are the highest land use category in Knox County at 34.94%. An additional 21.74% of land area is used for pasture and hay. Forested land is the second highest land use in Knox County, accounting for 34% of the county's land area. This includes 2,320 acres of state parks, forests, nature preserves and wildlife areas across six areas or facilities. Many of these parks and recreation areas are located in and around the Kokosing River.

As urban sprawl from Columbus continues to reach into Knox County, the need for residential growth continues. This trend was identified in the 2015 mitigation plan and has continued as of this plan update. Much of this residential growth is occurring in the southwest section of the county near the village of Centerburg and the surrounding townships. The Apple Valley community in eastern Knox County also continues to experience growth as people build year-round and seasonal residences in this unincorporated community.

Table 2-8: Knox County Land Use

Use Category	Percentage
Cultivated Crops	34.94%
Forest	34.42%
Pasture/Hay	21.74%
Developed, Lower Intensity	6.63%
Open Water	0.82%
Developed, Higher Intensity	0.52%
Shrub/Scrub and Grasslands	0.47%
Wetlands	0.42%
Barren (strip mines, gravel pits, etc.)	0.04%

2.1.10 Regulation

The Knox County Regional Planning Office, established in 1971, is the county agency responsible for addressing development issues within Knox County that are larger than a single jurisdiction or municipality. The office is responsible for administering floodplain regulations, subdivision regulations, Knox County airport zoning regulations and reviews amendments to township zoning regulations. Additionally, the office develops and maintains the Knox County Comprehensive Plan and coordinates the Knox County Regional Planning Commission.

Each incorporated municipality administers its own zoning and floodplain regulations. The Knox County Regional Planning Office administers floodplain regulations in the unincorporated areas of the county Each township adopts and administers local zoning regulations. All incorporated municipalities and eighteen of the county's 22 townships are zoned, as indicated in table 2-9.

Table 2-9: Township Zoning Status

Zoned		Not Zoned
Berlin	Middlebury	Butler
Brown	Milford	Clay
Clinton	Miller	Jackson
College	Monroe	Union
Harrison	Morgan	
Hilliar	Morris	
Howard	Pike	
Jefferson	Pleasant	
Liberty	Wayne	

2.1.11 Economy

Knox County's top five employment sectors are manufacturing; education and health services; trade, transportation and utilities; local government; and leisure and hospitality. Table 2-10 identifies the top employment sectors and average employment.

Table 2-10: Employment by Industry

Employment Sector	Average Employment
Manufacturing	4,524
Education and Health Services	4,255
Trade, Transportation and Utilities	2,950
Local Government	2,336
Leisure and Hospitality	1,919
Professional and Business Services	1,456
Construction	938
Other Services	544
Financial Services	519
State Government	289
Natural Resources and Mining	182
Information	149
Federal Government	104

Table 2-11 identifies the major employers across Knox County. These align closely with the top employment sectors.

Table 2-11: Major Employers

Employer	Sector
Ariel Ltd	Manufacturing
FT Prevision	Manufacturing
JELD-WEN Inc	Manufacturing
Kenyon College	Service
Knox Community Hospital	Service
Kokosing Construction Co	Construction
Mount Vernon Nazarene University	Service
Mount Vernon City Schools	Government
Sanoh America Inc	Manufacturing

2.1.12 Development Trends

Community development in Knox County is led primarily by the Knox County Regional Planning Commission in conjunction with jurisdictions, elected officials, community leaders, and stakeholders across Knox County. The Regional Planning Commission developed the county's first comprehensive land use plan in 1974. In the late 1990s, stakeholders recognized increasing development pressure and the need to update development practices to keep pace. This work resulted in the 1998 Knox County Comprehensive Plan, which identified four fundamental

guiding purposes to address long term community planning and recognized the potential community growth issues as the Columbus metropolitan region continued to grow.

In response to continued community development, the plan was updated again in 2006 and 2012. These updates recognized the achievements that came out of the 1998 plan, including development of the Farmland Preservation Task Force Report in 2000, a Cost of Community Services Study in 2003, and a Comprehensive Study of the Kokosing River Watershed in 2004. The 2012 update focused on sustainable growth and recognized the continued development of the 11-county central Ohio/Columbus metropolitan region and its potential impact on Knox County.

For the 2018 comprehensive plan update, the planning team identified goals and strategies that would advance the entire Knox County community. They discussed the idea of prioritizing quality commercial, industrial, and agricultural development over large-scale residential development opportunities because of the economic benefit of growing businesses. Recognizing the need for additional residential development, the planning team also urged local governments to use public-private partnerships with developers to support the cost of the infrastructure upgrades necessary to support residential growth. The 2019 plan update also recognizes the impact land development has on the health and safety of residents and references the 2015 Hazard Mitigation Plan as a central document in ensuring development and community growth do not compromise the health and safety of the community.

The 2018 plan update was developed with the intention of guiding Knox County's development for the next twenty years. While additional formal plan updates will certainly be completed over that timeframe, the planning team was asked to consider the needs and growth potential of the county over a two-decade timespan. It addresses key community issues such as responsible growth and economic diversity, education and workforce development, quality of life issues and preservation of environmental character.

2.2 HAZARD IDENTIFICATION

Knox County has experienced many disasters in its history, ranging from floods and tornadoes to blizzards and windstorms. In this section, the hazards that can impact the county are defined and the risk for each hazard is assessed. The Hazard Mitigation Planning Team analyzed the hazards and risks present throughout the county and identified eleven hazards as relevant to Knox County, as listed below.

- Drought/extreme heat
- Earthquake
- Flood
- Hazardous materials
- Infrastructure failure, including dams/levees, utility systems, water and wastewater systems, and roads and bridges
- Invasive species
- Land subsidence/landslide
- Severe thunderstorm
- Tornado and windstorm
- Water quality
- Winter Storm

Some hazards were excluded from this plan because they pose no risk to Knox County. The excluded hazards and the justification for the exclusion are identified in the table below.

Table 2-12: Excluded Hazards

Excluded Hazard	Justification
Coastal Erosion	The county has no open coastline.
Tsunami	Geographically impossible
Volcano	Geographically impossible
Wildfire	Insufficient forested area

Like most of Ohio, Knox County does not have a long history of federal disaster declarations or assistance. The county has been included in eight federal declarations. A comprehensive list of federal disaster declarations for Knox County is provided in table 2-13.

Table 2-13: Federal Disaster Declaration History

DR/EM Number	Incident Date	Incident Type(s)
DR-90-OH	01/23/1959	Flood
DR-3055-OH	01/26/1978	Winter Storm
DR-1227-OH	06/24/1998	Flood, Severe Summer Storm, Tornado
EM-3187-OH	08/14/2003	Other (power outage)
DR-1580-OH	12/22/2004	Flood, Mud/Landslide, Winter Storm
EM-3250-OH	09/13/2005	Other (Hurricane Katrina evacuation)
DR-1805-OH	09/14/2008	Wind
DR-4077-OH	06/29/2012	Wind, Severe Summer Storm

To understand the local risk posed by these hazards, the following pages examine the characteristics and evaluate the local history of each hazard. Historical information was obtained from the National Oceanic and Atmospheric Administration's National Climatic Data Center (NCDC) and supplemented with information from local officials.

2.2.1 Drought and Extreme Heat

A drought is a deficiency of moisture that adversely impacts people, animals, and vegetation over an area of significant size. Because drought is a creeping phenomenon characterized by the absence of water, there is no defined beginning or end or a specific amount of time required for an extended dry period to be considered a drought. An event is considered a drought when the dry period lasts long enough to impact the environment and economy of a region, typically several months or years.

Drought severity is measured using the Palmer Drought Severity Index (PDSI). The PDSI measures dryness based on recent precipitation and temperature statistics. Drought classifications are identified in the chart below:

Measurement	Description
-4 or less	Extreme Drought
-4 to -3	Severe Drought
-3 to -2	Moderate Drought
-2 to -1	Mild Drought
-1 to -0.5	Incipient Dry Spell
-0.5 to 0.5	Near Normal
0.5 to 1	Incipient Wet Spell
1 to 2	Slightly Wet
2 to 3	Moderately Wet
3 to 4	Very Wet
4 or more	Extremely Wet

A heat wave is a period of abnormally hot and unusually humid weather, typically lasting for two or more days. This can be an extended period with higher than normal temperatures or a shorter period with abnormally high temperatures. Regardless of the specific duration or temperature, heat waves are a safety hazard to anyone exposed to the extreme heat. People, especially the elderly and those with ongoing medical conditions, are at risk for heat exhaustion and heat stroke, which can be fatal in the most serious cases. When heat waves are accompanied by drought conditions, the potential for a serious natural disaster increases. Between injuries, fatalities, crop damage, and property damage, these disasters can significantly impact the economy of a region.

Heat waves can occur anywhere in Ohio but are typically brief, lasting only a few days. Extreme temperatures are considered anything above 90 degrees Fahrenheit. In the humid climate of the Midwest, these temperatures are often accompanied by high humidity. It is rare for temperatures to exceed the mid-90s, although the region does occasionally experience

temperatures in the upper 90s or slightly higher. These brief heat waves are not uncommon, but rarely last more than a few days. A heat wave lasting longer than a week is extremely uncommon.

Table 2-14: Average Temperatures and Rainfall

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg. High	33°	37°	47°	60°	70°	79°	82°	81°	74°	63°	50°	37°
Avg. Low	15°	18°	25°	36°	46°	56°	59°	56°	48°	37°	29°	20°
Avg. Precip.	2.83”	2.4”	3.15”	3.58”	4.41”	4.25”	4.17”	3.39”	3.31”	2.8”	3.23”	2.99”

Drought/Extreme Heat Risk Assessment

While it is not common, drought and extreme heat are countywide hazards that can affect all areas and jurisdictions. Knox County can experience slight drought and regularly experiences periods of decreased precipitation during the agricultural growing season. There is no history of an extended drought that caused property damage or human casualties. Reduced crop yields for a given year are possible, depending on precipitation patterns and in abnormally dry conditions. Knox County does not have any history of extensive multi-year crop losses.

Based on the U.S. Department of Agriculture’s 2017 Census of Agriculture, the market value of all agricultural products sold in Knox County is $135,144,000. In a drought, the crop and livestock operations across the county would be exposed to loss. Table 2-15 identifies the quantities of the primary agricultural commodities in the county that could be impacted by drought-related loss. While many farmers purchase crop insurance, there is no way to know the exact portion of crops that are insured across the county. Insurance is also only a partial financial remedy in the event of severe drought.

Table 2-15: Drought Vulnerability Assessment

Top Commodities	Crop Acres/Livestock Inventory
Soybeans	58,100 acres
Corn	56,000 acres
Winter Wheat	3,200 acres
Hogs/Pigs	34,406
Poultry/Layers	27,530
Cattle/Calves	21,958
Sheep/Lambs	7,901

Local Drought/Extreme Heat History

Drought and extreme heat have had some impact on Knox County in recent decades. Per official NDCD records, Knox County has experienced five official droughts and zero extreme heat events as indicated in the table below. Documented crop loss from these events is $5,000,000. Some drought events are documented in records from the United States Department of Agriculture rather than NCDC records so this information may not represent complete loss figures for all drought events. The USDA issues drought declarations and provides farmers and ranchers with disaster relief funding.

Table 2-16: Knox County Drought/Extreme Heat History

Hazard	Incidents	Property Loss	Crop Loss	Deaths	Injuries
Drought	5	0	5M	0	0
Extreme Heat	0	0	0	0	0

One of Ohio's more significant droughts was the 1988-1989 North American Drought. The incident was widespread and intense and included heat waves that killed thousands of people and substantial livestock nationwide. One of the underlying causes of the drought was the nationwide use of inappropriate land for agriculture production and continued over-pumping of groundwater. This major drought was catastrophic for the agriculture industry, destroying crops across the country. Water use restrictions were put in place across many jurisdictions. The drought continued to impact the Midwest and Northern Plains states during 1989 and was not declared over until 1990.

In the summer of 2012, Ohio was impacted by the 2012 North American Drought. This incident was an expansion of the 2010-2012 United States drought and began in the spring of 2012. Lack of snowfall across the county led to limited snowmelt and water that absorbed into the soil. The drought included most of the United States and all of Ohio. This drought has been compared to similar droughts in the 1930s and 1950s but did not last as long. The drought caused catastrophic economic ramifications. According to most measures, this drought exceeded the 1988-1989 North American Drought, which is the most recent comparable drought. On September 5, 2012, the USDA issued a disaster declaration for all counties in Ohio affected by the drought.

The most recent drought to affect Ohio occurred in 2016. On January 6, 2017, the USDA issued a disaster declaration for drought conditions experienced from May through October 2016. The primary declaration was issued for three Ohio counties; ten contiguous counties were also included in the declaration. Knox County was not identified as a primary or contiguous county in this declaration but many adjacent or nearby counties, including Delaware, Morrow, and Richland, were included in the declaration. All counties in the central Ohio region were impacted in some way by the abnormally dry conditions.

2.2.2 Earthquake

An earthquake occurs when two of earth's plates move past one another beneath earth's surface. The location where the plates meet is called a fault. The shifting of the plates causes movement along the fault line. This movement can often be felt in areas surrounding the earthquake's epicenter and can cause damage ranging from minor to devastating. Damage caused by an earthquake can include rattling foundations, falling debris, and, in the most severe cases, toppling buildings, bridges, and culverts. The severity of earthquake movement is measured using the Modified Mercalli Index scale as defined in this chart:

Intensity	Shaking	Description/Damage
I	Not Felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on building upper floors.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors. May not be recognized as an earthquake. Vibrations similar to a passing truck.
IV	Light	Felt indoors by many, outdoors by few. Windows and doors disturbed; walls make cracking sound. Sensation like heavy truck striking building.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very Strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures.
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures.
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations.

Earthquake Risk Assessment

In Knox County, earthquakes are geologically possible but extremely rare. Earthquake is a countywide hazard and can affect all areas and jurisdictions. Ohio has experienced more than 120 earthquakes since 1776. Only a few of these events have caused structural damage. West central and northeast Ohio are the regions with the highest earthquake risk. Knox County is not near either of these areas but does have some earthquake risk.

The planning team considered historical earthquake damage data and HAZUS loss projections for a 5.0 magnitude earthquake with an epicenter in Mount Vernon. Tables 2-17 and 2-18 describe the anticipated building damage and economic impact from this scenario.

Table 2-17: Expected Building Damage by Occupancy

Occupancy	None	Slight	Moderate	Extensive	Complete
Agriculture	141	56	62	30	7
Commercial	543	301	348	171	50
Education	40	17	18	7	2
Government	18	8	10	4	2
Industrial	217	105	126	66	18
Other Residential	1,119	556	536	212	47
Religion	95	44	40	20	6
Single Family Residential	12,610	4,695	2,240	596	164
Total	***14,783***	***5,782***	***3,380***	***1,106***	***296***

Table 2-18: Building-Related Economic Loss Estimates

Area	Single-Family	Other Residential	Commercial	Industrial	Other	Total
Income Losses						
Wage	0	2.14	21.43	1.50	2.14	27.21
Capital Related	0	0.91	18.44	0.91	0.71	20.97
Rental	6.68	6.88	9.65	0.46	1.05	24.72
Relocation	23.30	3.85	16.42	2.07	9.83	55.48
Capital Stock Losses						
Structural	37.59	14.01	25.20	7.67	11.57	96.03
Non-Structural	147.56	60.91	71.99	23.90	29.62	333.98
Content	60.02	18.24	40.03	16.77	18.64	153.70
Inventory	0	0	0.83	3.51	0.37	4.71
TOTAL	***275.15***	***106.95***	***204.00***	***56.80***	***73.92***	***716.81***

Table 2-19 is the county's overall vulnerability analysis for an earthquake based on HAZUS data.

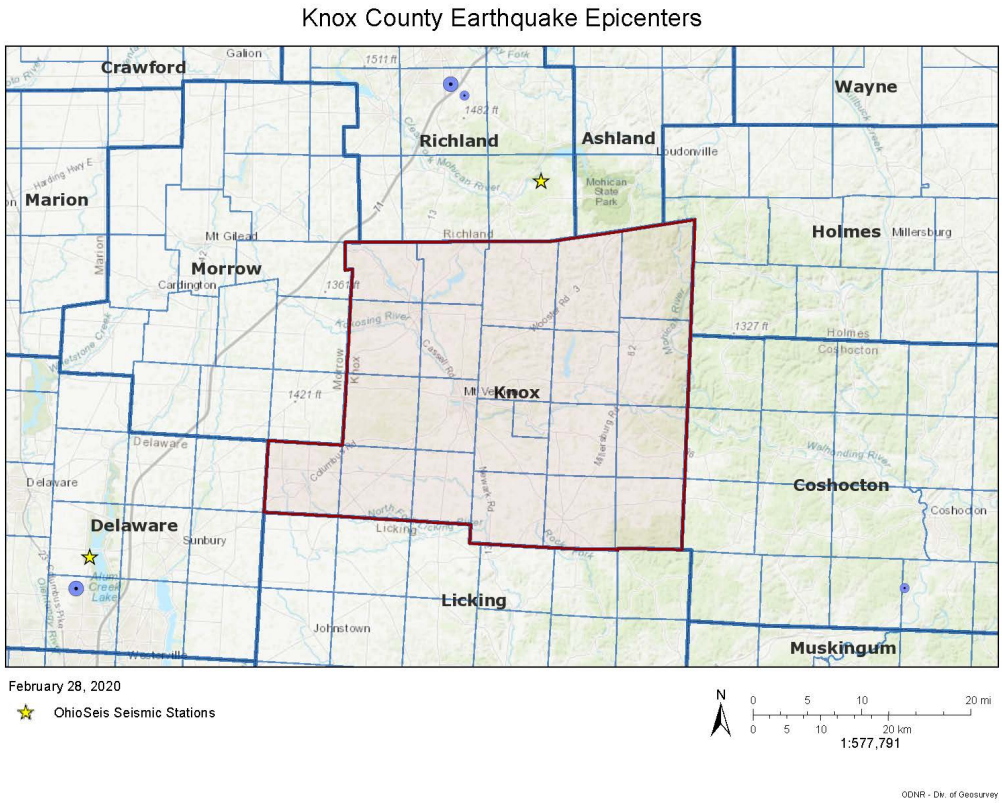
Table 2-19: Earthquake Scenario Vulnerability Analysis

Building Type	Number of Buildings	Exposure
Residential	3,000	$1,180,245,789
Non-Residential	1,672	$517,523,809
Critical Facilities	110	$34,047,619
Totals	*4,782*	*$1,731,817,218*

Local Earthquake History

Records from the Ohio Department of Natural Resources indicate that Knox County has experienced zero earthquakes with epicenters in the county. Several earthquakes have occurred in neighboring Delaware and Richland counties but there is no documentation of any direct impact in Knox County. Map 2-4 shows earthquake epicenters in the Knox County and the surrounding region.

Map 2-4: Knox County Earthquake Epicenters



The strongest earthquake recorded in Ohio occurred in Shelby County in 1937 and was estimated to have a magnitude of 5.5 on the Richter Scale. This incident caused some damage in Anna and surrounding west central Ohio communities. The same area in Ohio reported earthquake activity in 1875 and 1884. The Pomeroy area, southeast of Columbus, experienced an earthquake in 1926, and residents in Anna, near Lima in west central Ohio, felt minor quakes in 1930, 1931, and 1937. None of these earthquakes caused widespread damage or devastation. The minor quakes caused shaking buildings, crumbling mortar, and some limited property damage. Impacts were only felt locally; no statewide damages were reported.

2.2.3 Flood

According to the National Weather Service, a flood is defined as an overflow of water onto typically dry land. Riverine or flash flooding can cause the inundation of a normally dry area. Riverine flooding is caused by rising water from a nearby waterway, such as a river, stream, or drainage ditch. Flooding generally occurs subsequent to a meteorological event like substantial precipitation, rapid snowmelt, or extreme wind events along coastal waterways. This type of flooding can last days or weeks.

A flash flood is caused by heavy or excessive rainfall over a short period of time, typically less than six hours. These events are often characterized by raging torrents after heavy rains that impact riverbeds, streets, or low-lying areas and can occur within minutes or hours of excessive

rainfall. Flash flooding can also occur when the ground is too saturated, impervious, or flat to drain rainfall into waterways through storm sewers, ditches, creeks, and streams at the same rate as the precipitation falls. In some flash flood events, storm and/or sanitary sewer infrastructure can become overwhelmed, leading to sewer backup inside of structures.

Karst flooding occurs when the drainage capacity of an underground sinkhole is not adequate enough to transfer storm water runoff to the subsurface and the excess water pushes to the surface. Unlike riverine and flash flooding, this type of flooding occurs in the days and weeks after heavy precipitation events as the rainfall is absorbed into the ground and fills subsurface karst voids. As these voids fill to capacity, the water pushes through to the surface, flooding basements, yards, driveways, and anything else in the way. This type of flooding can only occur in areas with subsurface karst formations, which are not known to exist in Knox County.

Floods are the most common and costly disaster worldwide, resulting in significant loss of life and property. They have a substantial impact on infrastructure, including roadway breeches, bridge washouts, road wash away, and water-covered roadways. Fast-moving floodwater can wash away the surface and sub-surface of roads, creating holes, ruts, and other problems for vehicles. Floodwater that is one foot deep is strong enough to carry vehicles away.

Floodwaters seek the path of least resistance as they travel to lower ground and will seep into any structure in their path. Basements and lower levels of buildings can become inundated with floodwater. Installing sandbags along the exterior of a building can be a temporary stopgap measure but if floodwaters do not recede quickly, the force of the water will move through the sandbags and enter the structure.

The aftereffects of flooding can be just as damaging as the flood itself. Cleanup is often a long, protracted activity with its own set of hazards. Standing flood water can quickly become contaminated with household and industrial chemicals, fuel, and other materials that have leaked into the water. All floodwater is considered contaminated, either from germs and disease or hazardous materials. This creates a hazard for responders and residents throughout the cleanup phase.

Flood Risk Assessment

In Knox County, flooding is a moderate risk. It is a countywide hazard that can impact all jurisdictions. The county is susceptible to riverine flooding in some areas, primarily along the Kokosing River in central Knox County, the Mohican River in the northeast portion of the county, and the creeks, streams, and tributaries that feed into these waterways. These areas are somewhat low-lying, which increases their risk for flooding.

Flash flooding is a significantly greater risk for most areas of the county and accounts for more than half of all documented flooding incidents. Jurisdictions are susceptible to flash flooding when municipal stormwater systems are unable to keep pace with rapid precipitation events. This can also occur in rural areas of the county when ditches, creeks, and streams are unable to contain the rapid drainage caused by heavy rainfall. In jurisdictions and unincorporated areas of

the county, flash flooding can cause short-term road closures and long-term damage to roadways. Some structures experience minor basement flooding. While it is possible for some homes to experience significant flooding in primary living spaces, this is very rare.

Because of Knox County's rolling topography, surface runoff in agricultural areas is a concern. In flatter areas, field may be tiled to manage surface runoff but this is not an effective practice in areas with rolling topography. Ditches are also used to route runoff water into creeks and streams and contain runoff from roads and other properties. When flooding events occur during the winter, floodwaters tend to be deeper and take longer to drain because the ground is already frozen and cannot absorb floodwater. After heavy precipitation events, some roads are vulnerable to flooding and may be closed briefly until floodwater recedes.

Local flood damage can include damage or destruction of physical structures, infrastructure, crops, and livestock. Residential structural damages could include single and multi-family homes, group living facilities, and multi-family housing complexes. Commercial and industrial structural damages could include buildings used for manufacturing, product handling, transportation, warehousing, retail, business, and industrial, and the capital equipment associated with those uses. Agricultural structures would include barns used for livestock, storage buildings, equipment, and machinery. Government, nonprofit, and educational institutions include critical structures like fire stations, police stations, hospitals, schools, and maintenance buildings; damage could include the physical structure as well as the contents. This damage would result in large amounts of debris to manage. It is unlikely that loss of life would be attributed to flooding. If a death were to occur, it would likely be the result of two or more combined threats, such as lightning, tornado, or driving into standing water.

The vulnerability analysis in the following table is based on HAZUS data simulating a 100-year flood in Knox County.

Table 2-20: 100-Year Flood Scenario Vulnerability Analysis

Building Type	Number of Buildings	Exposure
Residential	5,479	$1,511,027,000
Non-Residential	1,400	$387,995,000
Critical Facilities	1,059	$294,074,000
Totals	*7,937*	*$2,196,096,000*

Floodplain Mapping and National Flood Insurance Program

Knox County's floodplain maps were updated in 2009 as part of FEMA's Map Modernization Program. The current floodplain maps became effective July 7, 2009. The tables below provide information on participation in the National Flood Insurance Program for Knox County communities as identified in FEMA's Community Status Book for Ohio. The communities in table 2-21 participate in NFIP and are considered to be in good standing with the program. Only one community, as identified in table 2-21, is under sanction from NFIP.

The villages of Danville and Martinsburg do not currently participate in NFIP because there is no special flood hazard area identified within the village limits.

Table 2-21: NFIP Participating Communities

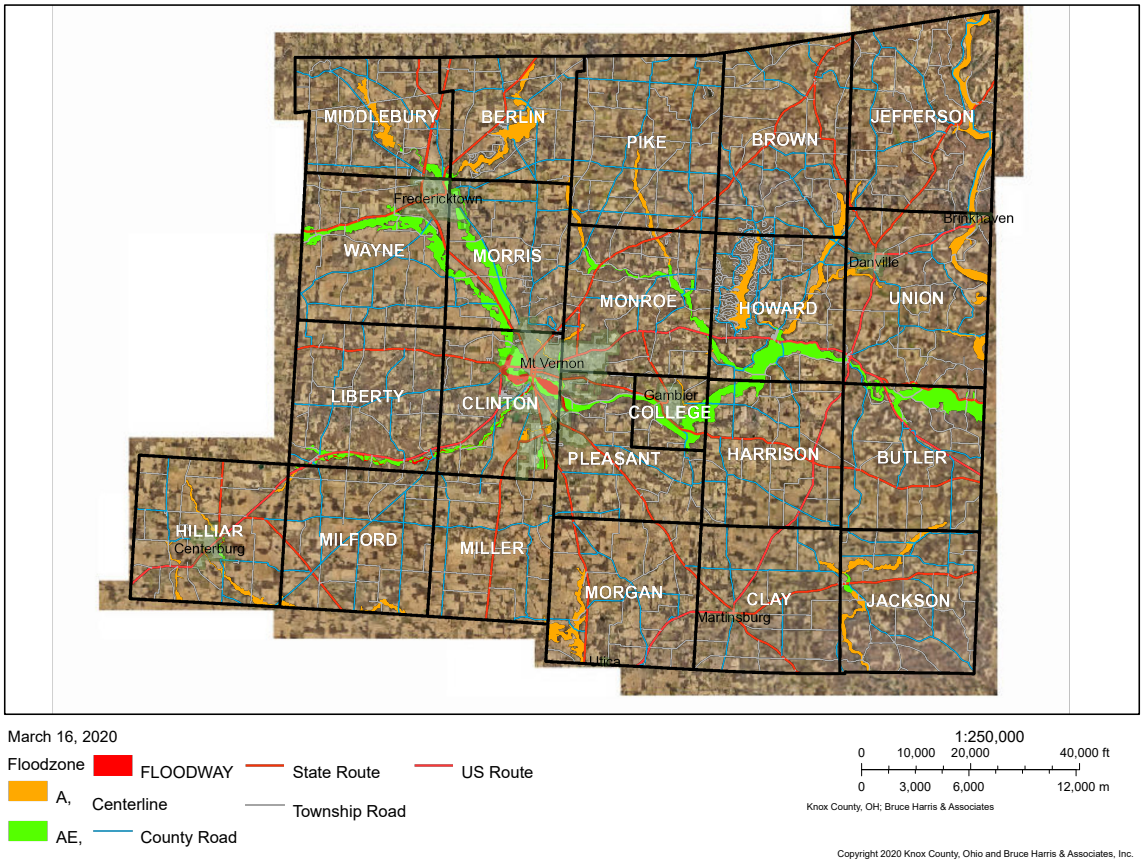
Community	Initial FHBM Identified	Initial FIRM Identified	Current Map Effective Date	Reg-Emer Date
Knox County	01/31/75	07/19/82	07/07/09	10/27/93
Centerburg	05/17/74	01/06/82	07/07/09	01/06/82
Fredericktown	04/05/74	02/18/81	07/07/09	02/18/81
Gambier	05/17/74	01/30/81	07/07/09(M)	01/30/81
Mount Vernon	05/03/74	08/02/82	07/07/09	08/02/82

Table 2-22: NFIP Sanctioned Communities

Community	Initial FHBM Identified	Initial FIRM Identified	Current Map Effective Date	Reg-Emer Date
Gann/Brinkhaven	--	07/07/09	07/07/09	07/07/10

Map 2-5: Knox County Floodplain

Knox County Floodplain Area



Repetitive and Severe Repetitive Loss Structures
Within Knox County, there are three known repetitive loss structure as of August 31, 2018. Locations and recorded loss data are provided in the table below.

Table 2-23: Repetitive Loss Properties

Community	Occupancy	Losses	Building Payments	Contents Payments	Total Payments
Fredericktown	Single Family	2	$7,421.99	$1,218.47	$8,640.46
Knox County	Single Family	2	$31,814.00	0	$31,814.00
Mount Vernon	Single Family	2	$9,194.61	0	$9,194.61

Local Flood History
Per NCDC records, Knox County has experienced 9 floods and 19 flash floods since 1950. Property and crop damage from these incidents have been extensive, as identified in table 2-24.

Table 2-24: Knox County Flood History

Hazard	Incidents	Property Loss	Crop Loss	Deaths	Injuries
Flood	9	1.45M	0	0	0
Flash Flood	19	10.82M	1.53M	0	0

Of the documented flood incidents in the county, some have been much more significant than others. One such significant event occurred on June 27, 1998 when a line of heavy thunderstorms impacted Knox County. Throughout the afternoon, heavy precipitation caused major flooding in many areas of the county. More than 100 people were evacuated from homes; several had to be rescued from vehicles and buildings as the rapidly rising floodwater caused them to become trapped. Nine bridges and multiple roads were washed out. The storm system dumped a total of ten inches of rain on the area in the course of one day and floodwaters didn't recede for days. Following this incident, Knox County was declared a state and federal disaster area. Total property damages exceeded $6,000,000 and crop losses reached $1,500,000.

Another significant flood incident occurred in northeastern Knox County on July 10, 2006. Reported rainfall totals were between 7 and 7.5 inches over the afternoon and evening hours. This heavy rainfall caused the Mohican River and Jelloway Creek to rise rapidly and overflow their banks. Many mobile homes and campers were destroyed and hundreds of people were evacuated from the many campgrounds located along the river. Additional evacuations occurred in Jelloway and Danville. More than 24 roads were closed because of high water, including five that were completely washed out. In total, the flooding caused $3,500,000 in property damage.

A more recent significant flood incident occurred on July 8, 2013 following a day of heavy rainfall. Flooding was widespread across central and north central Ohio, including areas of Knox, Morrow, Richland, and Seneca Counties. In Knox County, at least ten roads were closed

due to high water. Fredericktown and Danville were the most impacted areas of the county. Camp Kokosing, along the North Branch of the Kokosing River, was inundated with three to five feet of water, causing campers to be moved to higher ground. In all, this incident caused $200,000 in property damage.

2.2.4 Hazardous Materials Incident

A hazardous materials spill or release occurs when a hazardous substance breaches its container. The release can occur during operations at a fixed facility or during ground or rail transportation of the substance. Hazardous substances are stored in numerous types of containers, including drums, cans, jars, pipes, and other vessels. Some releases are incidental and can be safely cleaned up by on-site facility personnel. An incidental release does not threaten the health or safety of the immediate area or community because the spill involves only a small quantity. If the release involves a larger quantity than can be handled by facility personnel and requires action by first responders or agencies outside of the spiller's facility, the incident is considered an emergency response. To protect the community, evacuation from the facility or area surrounding the spill may be necessary.

Every hazardous substance is unique and can have toxic, flammable, explosive, and/or corrosive properties. Each material is assigned a class based on these properties; hazardous materials classifications are described in the table below. When a hazardous substance is released into the environment, it can negatively impact the safety and health of the community by contaminating the air, water, and/or ground.

Class	Description
1	Explosives
2	Gases
3	Flammable liquids and combustible liquid
4	Flammable solid, spontaneously combustible, dangerous when wet
5	Oxidizer and organic peroxide
6	Poison (toxic) and poison inhalation hazard
7	Radioactive
8	Corrosive
9	Miscellaneous

Traffic accidents on roadways can cause the vehicles carrying hazardous substances to overturn, collide with other vehicles, or ignite and burn. The runoff caused by chemical spills, the vapors created as a chemical dissipates, or the burning of a substance can expose anyone in the immediate vicinity of the incident to extreme danger. Vehicular accidents compound the vulnerabilities of people and the environment to include both traumatic injury due to the crash or kinetics of the incident and the negative effects of absorbing the chemical that is released into the atmosphere.

Injuries from exposure to hazardous substances can involve direct contact with the substance and traumatic injuries from explosions or fires. Most hazardous materials releases involve the

breech of a container or the unintended combining of chemicals. These spills and leaks can occur in businesses, homes, and industries or anywhere else that hazardous substances exist.

There is no unified reporting system for hazardous materials incidents. Industrial spills involving reportable quantities are documented in accordance with state and federal regulations. Smaller spills often go undocumented unless someone is hurt and requires medical attention. Large industrial spills and leaks are investigated by local hazardous materials teams, regulators, and government responders. Spills that occur on highways and railroads become known because local first responders and emergency management officials are involved in responding to the incident. Incidents of non-lethal exposure, such as a small chemical spill in a residence or a broken mercury thermometer, may not even be recognized as an emergency. Individuals do not always know the risks associates with these incidents so they clean up the spill as best they can without any additional reporting.

Hazardous Materials Incident Risk Assessment

Knox County has a moderate risk for hazardous materials incidents. Within the county, there are numerous facilities that manufacture, utilize, and/or store hazardous substances. There are also multiple grain and livestock farms that use fertilizers, pesticides, and other agricultural chemicals in the course of production. Individual homes have chemicals and substances used to care for their property, such as fuel and fertilizer. Hazardous substances are transported on county roads and state highways. Populated jurisdictions along these highways are particularly vulnerable to hazardous materials incidents because of their proximity to the major transportation routes on which these substances are carried.

Pipelines are also present throughout Knox County, particularly in the central and southwest portions of the county. Map 2-6 identifies the county's 115 miles of gas transmission pipelines. While it is believed that the pipelines are well maintained, there is always a risk for an incident. First responders participate in training to prepare for these potential responses.

Because of the movement of hazardous materials on different types of transportation systems throughout the county, hazardous materials incidents are a countywide hazard and can affect all areas and jurisdictions.

Local Hazardous Materials Incident History

Hazardous materials incidents in Knox County are monitored by the Local Emergency Planning Committee (LEPC). Based on these records, the county averages approximately 3.1 hazardous materials incidents per year. The majority of these are minor vehicle incidents involved diesel fuel spills. Table 2-25 identifies the number of incidents per year over the last decade.

Table 2-25: Hazardous Materials Incidents

Year	Incidents
2010	2
2011	5
2012	3
2013	4
2014	3
2015	4
2016	1
2017	1
2018	5
2019	4

2.2.5 Infrastructure Failure

Infrastructure is defined as the basic physical and organizational structures and facilities that are necessary for the operation of a society. It includes, but is not limited to, buildings, roads, power supplies, water, wastewater, and other utility systems. These essential services, structures, and systems are critical to the function of a community. For the purpose of hazard mitigation, this plan will address these types of infrastructure failure: dams and levees; roads and bridges; and utility systems, including electricity, storm sewers, wastewater, and water treatment/distribution

2.2.5 A Dam and Levee Systems

A dam is an artificial barrier built across flowing water. This barrier directs or slows the flow of water and often creates a lake or reservoir. A dam is considered hydrologically significant if it has a height of at least 25 feet from the natural streambed and a storage capacity of at least fifteen acre-feet or an impounding capacity of at least 50 acre-feet and is six feet or more above the natural streambed. Dams are constructed for different purposes, including flood control or water storage for irrigation, water supply, or energy generation. They can be composed of earth, rock, concrete, masonry, timber, or a combination of materials. A low head dam is a manmade obstruction that is built within a waterway spanning from bank to bank. These dams have water flowing across the top of the dam and are typically one to fifteen feet tall. Most low head dams are designed to control upstream water levels; they do not typically provide any flood control function.

Levees are embankments constructed to prevent the overflow of a river and subsequent flooding of the surrounding land. They can be built using earth, rock, or other materials. Levees constructed from concrete or masonry materials are referred to as floodwalls.

Many of the structures classified as dams or levees in Ohio are part of municipal water or wastewater treatment systems. These structures are often referred to as upground reservoirs or lagoons. According to ODNR, an upground reservoir is defined as a reservoir formed by

artificial barriers on two or more sides and which impounds water or liquefied material pumped or otherwise imported from an exterior source. Lagoons are considered upground reservoirs.

Dam failure is defined as the uncontrolled release of the water held back by the structure. Depending on the storage volume of the dam and the types of structures surrounding it, a breach or failure can have a significant or limited impact on the surrounding community. In the most significant dam failure incidents, there can be substantial flooding downstream, damage to property, and loss of life. Potential causes of dam failure include, but are not limited to, substandard construction, geological instability, spillway design error, poor maintenance, internal erosion, and/or extreme inflow.

A levee failure occurs when something about the levee failed to prevent flooding on the land side of the levee. The reasons for levee failure can include erosion and damage from wind and water, the sudden or gradual failure of the levee's foundation, or overtopping of the levee. A levee can also breach if an object hits or falls on the levee (such as a tree or structure) and the force of the object destabilizes the levee, allowing water to flow to the land side of the levee.

The Ohio Department of Natural Resources (ODNR) is responsible for determining dam risk through their Dam Safety Program. ODNR classifies dams based on this scale:

Classification	Description
Class I	High hazard dam; probably loss of life, serious hazard to health, structural damage to high value property (i.e. homes, industries, major public utilities).
Class II	Significant hazard dam; floodwater damage to homes, businesses, industrial structures (no loss of live anticipated), damage to state and interstate highways, railroads; only access to residential areas.
Class III	Low hazard dam; damage to low value non-residential structures, local roads, agricultural crops, and livestock.
Class IV	Losses, if any, restricted mainly to the dam.

Dam/Levee Failure Risk Assessment

There are 57 dams and 6 levee structures in Knox County. The county's dam inventory includes six Class I structures, seven Class II structures, and four Class III structures. The remaining 40 structures are considered Class IV. Four dam structures are considered low head dams. Many of the Class IV structures function as water retention structures on agriculture ponds, small waterways that hold back a recreational water supply, or are privately owned structures that affect the flow of runoff waters. The complete list of dams and classifications are identified in table 2-26.

Table 2-26: Knox County Dams

Dam	Class	Location	Owner	EAP
Anjecondy Lake Dam	II	Liberty Township	Private	Yes
Apple Valley Lake Dam	I	Howard Township	Private, Association	Yes
Ashley Lake Dam	II	Pike Township	Private	Yes

Dam	Class	Location	Owner	EAP
Balaz Lake Dam	IV	Monroe Township	Private	N/A
Baldwin Lake Dam	IV	Liberty Township	Private	N/A
Beam Lake Dam	IV	Clinton Township	Private	N/A
Bennett Lake Dam	IV	Monroe Township	Private	N/A
Breslin Lake Dam	IV	Harrison Township	Private	N/A
Burke Lake Dam	IV	Milford Township	Private	N/A
CCC Lake Dam	IV	Hilliar Township	Private	N/A
Cline Lake Dam	III	Clinton Township	Private	N/A
Coxley Lake Dam	IV	Milford Township	Private	N/A
Ewers Lake Dam	III	Middlebury Township	Private	N/A
G. Martin Corporation Dam	IV	Milford Township	Private	N/A
Gambier Fishing Club Lake Dam	IV	Harrison Township	Private	N/A
Golf Course Lake Dam	IV	Monroe Township	Private	N/A
Hamon Lake Dam	IV	Morris Township	Private	N/A
Hance Lake Dam	III	Liberty Township	Private	N/A
Henwood Lake Dam	IV	Monroe Township	Private	N/A
Hillier Lake Dam	IV	Pleasant Township	Private	N/A
Hipps Lake Dam	IV	Liberty Township	Private	N/A
Izzard Lake Dam	IV	Morgan Township	Private	N/A
Kaiser Lake Dam	IV	Morgan Township	Private	N/A
Knox Cattle Company Dam	I	Mount Vernon	Private	No
Knox County Fairgrounds Lake Dam	IV	Morris Township	Public, Local	N/A
Knox Lake Dam	I	Berlin Township	Public, State	Yes
Lake Damascus Dam	I	Hilliar Township	Private	Yes
Lake Ralph Dam	II	Howard Township	Private	N/A
Lake Viering Dam	I	Pike Township	Private	Yes
Lakes at Wolf Run Basin A Dam	IV	Monroe Township	Private	N/A
Lakes at Wolf Run Basin B Dam	IV	Monroe Township	Private	N/A
Lakes at Wolf Run Basin C Dam	IV	Monroe Township	Private	N/A
Lakeview Lake Dam	IV	Clay Township	Private	N/A
Merscher Lake Dam	IV	Harrison Township	Private	N/A
Mickley Lake Dam	IV	Jefferson Township	Private	N/A
Miller Lake Dam	IV	Milford Township	Private	N/A
Miller Pond Dam	IV	Clay Township	Private	N/A
Millwood Plant Dam	II	Union Township	Mining	
Millwood Plant Slurry Impoundment Dam	IV	Union Township	Industrial	N/A
N. Branch of Kokosing River Lake Dam	I	Middlebury Township	Public, Federal	Yes
Neutralized Water Impoundment 2	II	Union Township	Mining	Yes
Neutralized Water Impoundment 3	II	Union Township	Mining	Yes
Olin Lake Dam	IV	Middlebury Township	Private	N/A
Pipes Lake Dam	IV	Pike Township	Private	N/A
Reed Lake Dam	IV	Berlin Township	Private	N/A
Roach Pond Dam	IV	Howard Township	Private	N/A
Robbins Lake Dam	III			N/A

Dam	Class	Location	Owner	EAP
Schnormeier Lake Dam	IV	College Township	Private	N/A
Simmons Lake Dam	IV	Morgan Township	Private	N/A
Tu Pond Dam	IV	Howard Township	Private	N/A
Wakatomika Lake Dam	IV	Union Township	Private	N/A
Watson Lake Dam	IV	Hilliar Township	Private	N/A
Wolfe Lake Dam	IV	Butler Township	Private	N/A
Workman Lake Dam	II	Union Township	Private	Yes
Yoder #2 Dam	IV	Brown Township	Private	N/A
Yoder Dam	IV	Brown Township	Private	N/A
Zeigler Lake Dam	IV	Liberty Township	Private	N/A

For most of the county's high hazard dams, emergency action plans (EAPs) are current and in place, as indicated in the table below. The exception to this is the Knox Cattle Company Dam in Mount Vernon. While this dam does not have a current EAP, conversations are ongoing between the homeowners' association, Mount Vernon officials, and ODNR to remedy this issue.

Some data regarding the safety of dam infrastructure, including EAPs and inundation maps, cannot be distributed to unauthorized personnel in accordance with Ohio Revised Code Section 149.433(a). These documents are developed and maintained by the dam owner and kept on file with the county's Emergency Management Agency and the ODNR Dam Safety Program.

While there are no documented incidents of dam failure in Knox County, there have been several dam-related incidents. A list of these incidents, according to the Stanford University National Performance of Dams Program, is provided in table 2-27.

Table 2-27: Dam Incidents

Structure Name	Hazard Potential	Incident Date	Incident	Dam Failure
Anjeconda Lake Dam	Significant	03/13/2000	Inadequate spillway capacity	No
Lake Viering Dam	Significant	03/13/2000	Inadequate spillway capacity	No
Ashley Lake Dam	Significant	03/13/2000	Inadequate spillway capacity	No
Knox Lake Dam	High	12/16/1998	Embankment erosion; concrete deterioration	No
Knox Cattle Company	High	06/27/1998	Inflow flood – Hydrologic event	No

The risk of dam in Knox County is moderate, in part due to the high number of Class I, II, and III dams in the county. While most of the high hazard dams have the necessary emergency action plans in place, there are residential and commercial neighborhoods located in their inundation zones. The dams on Knox Lake and Apple Valley Lake are in highly populated areas, making maintenance of those dams a high priority. The Knox Lake dam is located north of Fredericktown and has several residential neighborhoods within its inundation zone. Because

the dam is well maintained, village officials do not consider it to be a major threat but recognize that continuing maintenance is critical to protecting the surrounding community. The situation is similar for the Apple Valley Lake dam. The community surrounding this dam includes year-round and seasonal residences. The dam is well maintained and considered safe by local officials. The dam on Kokosing Lake, formally known as the N. Branch of Kokosing River Lake Dam, is federally owned and maintained and located northwest of Fredericktown. This rural area does not have many residential structures but there are several businesses and recreational areas, including a disk golf course and campground, that are near the dam and spillway. Like the Knox Lake Dam, maintaining this structure is important but it is known to currently be in good condition. The Lake Damascus Dam in Hilliar Township is owned and maintained by the Damascus Catholic Mission Camp. The dam is located in a rural area north of Centerburg. The camp, which hosts youth camps and adult retreats throughout the year, is the only thing in the dam's inundation zone. The Lake Viering Dam is a class I structure located on Lake Viering, a man-made lake in northeast Pike Township. This dam is privately owned and located in a rural area. There are approximately six residential structures built along the lakeshore. According to EMA records, these dams have the necessary emergency plans in place.

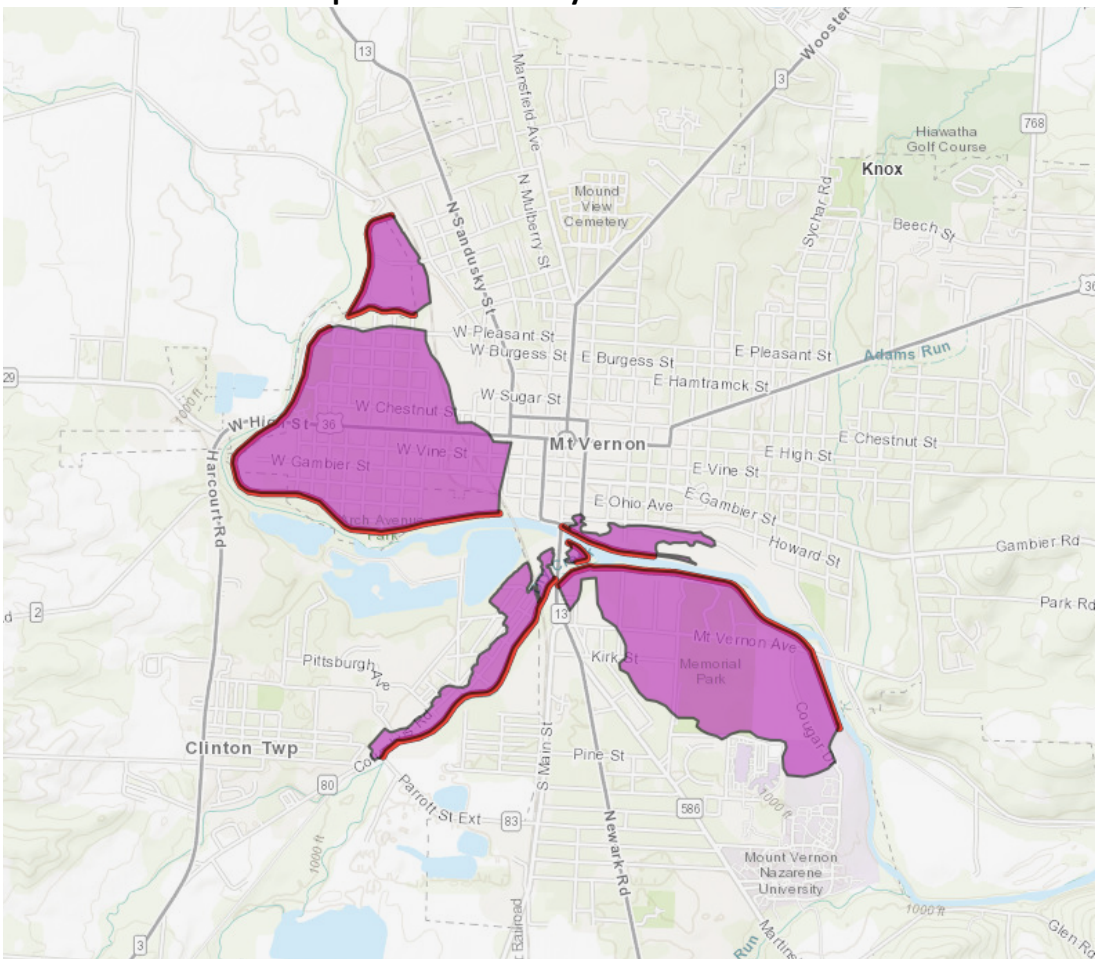
The Class I Knox Cattle Company Dam in Mount Vernon is an area of concern. This dam is located in a residential development on the east side of Mount Vernon and is considered to be in need to some repair and maintenance. Dam ownership is in question, however, as leadership of the homeowner's association has changed over the years. Mount Vernon officials have been working with the Ohio Department of Natural Resources and the homeowner's association for the residential neighborhood to determine financial responsibility for the repairs and more forward with the necessary maintenance.

According to the National Levee Database, there are six identified levee structures in Knox County. These levees are all located in along the Kokosing River in Mount Vernon. The levees are designed to protect the city from flooding on the river. They are locally maintained and considered to be in good repair. Given their location in Mount Vernon, the most populated jurisdiction in the county, there are a number of structures located behind some of the levees. The length of the structures and population and property behind each is identified in the table below. Map 2-5 shows the potential risk zone for each levee, according to the National Levee database. Given the limited number of levees and lack of prior incidents, levee failure is considered a lower risk than dam failure for the county.

Table 2-28: Knox County Levee Risk Data

Structure	Miles	Population	Structures	Property Value
Mount Vernon Levee	0.12	0	3	$3.22M
Mount Vernon Levee 2	1.54	1,542	686	$235M
Mount Vernon Levee Dry Creek	0.86	300	93	$29.5M
Mount Vernon Levee Segment #3	1.21	519	40	$87.8M
Mount Vernon Levee Segment #6	0.32	1	1	$219K
Mount Vernon Levee Segment #7	0.62	0	0	0

Map 2-5: Knox County Levee Structures



2.2.5 B Roads and Bridges

Transportation infrastructure is a critical part of any community. The roads, bridges, and associated system components that allow people to travel through the community are critical to commerce and daily life. The maintenance of roads and bridges is shared between multiple government entities, depending on the type of roadway. State highways and interstates are maintained by the Ohio Department of Transportation. County roads are the responsibility of the Knox County Engineer. City and village streets are maintained by municipal street departments. Some townships have road departments while others contract with the county engineer for road maintenance issues. This is especially likely in small jurisdictions that have a limited budget to hire employees or maintain equipment.

Road and Bridge Failure Risk Assessment

Roads and bridges are critical transportation assets in every community and require continual maintenance and repair. These resources are used heavily by the public and are highly vulnerable to damage from water, wind, and general wear. Weather conditions, standing water, continual freezing and thawing, and the salt and chemicals used to treat roads in winter weather all have a long-term impact on the strength of roadways. As communities grow and

transportation needs change, roads and bridges must be also upgraded to meet changing traffic patterns. The county and municipalities work diligently to maintain their critical transportation assets and provide safe and reliable transportation routes for the public. In most cases, road repair and maintenance accounts for a significant portion of each jurisdiction's annual budget. They also apply for grants and pursue other funding opportunities to fund road maintenance and improvements. Even with these efforts, roadways across the county are always in need to repairs or upgrades that aren't feasible within county or municipal budgets.

Local Road and Bridge Failure History

Road maintenance is an ongoing challenge in Knox County. Every jurisdiction has a list of roads and bridges that need to be repaved, repaired, or completely replaced. They address these projects as aggressively as possible, depending on funds. When grants and outside funding sources are available, jurisdictions pursue those programs to continue this work.

2.2.5 C Utility Systems

Utility system is a broad term for the many systems that provide essential services and amenities to the public. This includes water treatment and distribution, wastewater, stormwater, electricity, and natural gas delivery. These systems can be built and maintained by a public entity, usually a jurisdiction or public cooperative, or by private companies. Water, wastewater, and storm water utilities are generally operated by public entities, although privately owned water systems do exist. Electricity in many jurisdictions is provided by private providers; a few municipalities, however, own and operate their own municipal electric system. In rural areas, many homes receive these basic utilities through individual systems, such as water wells and septic systems. Regardless of the type of delivery, utility systems provide critical services to the community. These systems are vulnerable to failure caused by disaster conditions or circumstances that occur independent of any hazard or storm.

Utility Systems Risk Assessment

Utility systems are vulnerable to failure caused by general system malfunction, poor maintenance, aging system components, and overuse. All utility systems, even those that are well maintained, are susceptible to these issues. Utility systems are incredibly expensive to operate and maintain. As time goes on, they require upgrades and replacement to continue meeting the needs of the public. Community growth and development also dictate expansion needs so the systems can meet increasing demand. Changes in regulations also require systems to be upgraded or modified. All of these actions are extremely expensive. While the cost is initially the responsibility of the jurisdiction or entity that manages the system, the expense is eventually passed on to the user through fees.

Because of the overwhelming expense of maintaining and upgrading these systems, many are not in good repair. Water distribution lines are old and undersized. Wastewater and stormwater systems that were combined when the system was originally built have not been fully separated in spite of regulations requiring separation. Stormwater systems that were adequate 40 years ago are undersized by today's standards and unable to manage the level of precipitation communities experience today. Many electric and natural gas distribution systems

have not been upgraded to keep pace with community growth. This is true for infrastructure systems across Knox County.

Infrastructure failure was considered the highest risk across Knox County, particularly for stormwater, wastewater, and water treatment systems. Electrical utilities were also considered a high risk because the population is so dependent on electricity for essential daily functions. Communities recognize how critical these systems are to the public and are working diligently to identify funding to upgrade and maintain their systems. These efforts include borrowing funds, applying for grants, and increasing user fees and any other funding opportunities they can identify. Because every community relies on utility infrastructure for critical services, infrastructure failure is a countywide hazard that can affect all jurisdictions and areas of Knox County.

Local Utility System Failure History

Knox County has experienced several incidents that had a major impact on utility systems. Several of these occurred as a result of a natural hazard while one was specifically related to the failure of a utility system. On January 5, 2005, Knox County and a significant portion of central and northern Ohio was impacted by a severe ice storm. Thousands of trees and utility poles across the region were covered in ice, damaging electric lines and poles and causing outages that lasted as long ten days in some areas. This extended power outage created significant hardship across the community for businesses and individuals. Business operations came to a halt and people were forced to find shelter somewhere with electricity for several days. This storm caused more than $6,800,000 in damage in Knox County and $125,000,000 statewide. While this incident is classified as an ice storm, the power outages were the primary issue that caused hardship and property loss.

Several years later, in September 2008, most of Ohio, including Knox County, was impacted by another major power outage. As the sub-tropical remnants of Hurricane Ike traveled north from the Gulf of Mexico, heavy winds affected significant portions of the Midwest. In Ohio, the sustained 75 mph winds caused an estimated 2.6 million power outages. While some outages were brief, more than 300,000 people were without power for more than a week. Businesses were shut down, leading to significant economic loss. Knox County suffered $4,000,000 in property loss and $750,000 in crop damage. Like the 2005 ice storm, this incident is technically considered a natural event but the power outages were the primary source of hardship and damage to the community.

One notable utility failure that was completely independent of a storm event was the Northeast Blackout on August 14, 2003. This widespread power outage affected nearly 45 million people in eight U.S. states plus 10 million people in Canada. The outage was caused by a system failure. In Ohio, more than 500,000 people were without power. The outage area in Ohio included Knox County and many adjacent areas. Businesses were forced to close and people with special medical needs were unable to meet those needs without access to electricity.

2.2.6 Invasive Species

An invasive species is a plant or animal species that is not native to the local ecosystem and whose introduction is likely to cause economic or environmental harm or harm to human life. Across the United States, more than 5,000 species are recognized as invasive; these species are classified as terrestrial plants, terrestrial wildlife, insects and diseases, and aquatic species.

Invasive terrestrial plants can displace native species, impact the wildlife that rely on native species as a source of food or shelter, or form monoculture plant communities that reduce biodiversity. While more than 25% of the plant species in Ohio originate from other areas, most are not invasive; fewer than 100 species are actually considered invasive.

Invasive terrestrial wildlife is much less common but can still cause significant damage to natural habitats. Aquatic invasive species are plants and animals that impact the quality of waterways. These can affect large bodies of water, such as Lake Erie and the Ohio River, and much smaller rivers, lakes, and streams. Invasive insects and diseases are insects, fungus, and other small organisms that can negatively impact plants, forests, and the health of wildlife. Table 2-29 identifies the invasive species that have the greatest impact in Ohio.

Table 2-29: Invasive Species in Ohio

Species	Type
Asian Carp	Aquatic
Curlyleaf Pondweed	Aquatic
Hydrilla	Aquatic
Round Goby	Aquatic
Ruffe	Aquatic
Red Swamp Crayfish	Aquatic
Sea Lamprey	Aquatic
White Perch	Aquatic
Zebra Mussel	Aquatic
Asian Longhorned Beetle	Insects & Diseases
Emerald Ash Borer	Insects & Diseases
Gypsy Moth	Insects & Diseases
Hemlock Wooly Adelgid (HWA)	Insects & Diseases
Walnut Twig Beetle	Insects & Diseases
Japanese Honeysuckle	Terrestrial Plant
Japanese Knotweed	Terrestrial Plant
Autumn-Olive	Terrestrial Plant
Buckthorns	Terrestrial Plant
Purple Loosestrife	Terrestrial Plant
Common Reed or Phragmites	Terrestrial Plant
Reed Canary Grass	Terrestrial Plant
Garlic Mustard	Terrestrial Plant
Multiflora Rose	Terrestrial Plant
Bush Honeysuckles	Terrestrial Plant

Species	Type
Feral Swine	Terrestrial Wildlife

Invasive Species Risk Assessment

Like most counties in Ohio, Knox County is heavily populated with trees and wooded areas, all of which are vulnerable to damage from invasive species. When trees that are dead or weakened from invasive species fall, they become storm debris and can damage homes, buildings, vehicles, and anything else in their path. Diseased trees also fall into rivers, creeks, and streams, clogging the waterways and impeding drainage and increasing the county's vulnerability to flooding.

The most recent invasive species to impact Ohio, including Knox County, is the Emerald Ash Borer. The county is equally vulnerable to damage caused by other tree-infecting insects. Waterways could also be impacted by invasive plant and animal species. An infestation of any type would cause damage across the county, making invasive species a countywide hazard that can affect all areas and jurisdictions.

The cost to a community from invasive species is difficult to quantify because it comes from the long-term effects and cleanup costs rather than direct property damage. Actions like removing and disposing of diseased trees and vegetation, repairing damage caused by falling trees, cleaning and dredging debris-filled waterways, and repairing infrastructure damaged by the infestation are all costs associated with invasive species. These tasks are extremely expensive and can cost jurisdictions hundreds of thousands of dollars.

Local Invasive Species History

Emerald Ash Borer (EAB) is the most recent invasive species to impact Ohio. EAB is an ash-tree killing insect native to Asia that kills trees within three to five years of infestation. It was first discovered in Ohio in 2003. Knox County was not one of the most heavily affected areas of the state but was impacted by the infestation and statewide quarantine on ash wood. The quarantine was lifted in 2011, indicating that the worst of the infestation has passed. While the actual infestation threat has passed, most communities are still dealing with the thousands of dead and diseased trees that have not been removed. It will take individual property owners and communities thousands of dollars and years of time to remove these trees. From a disaster perspective, these weakened trees create an increased risk for property damage from high wind events. Dead and diseased trees are extremely susceptible to wind damage. Along waterways, diseased trees also increase flood risk as they fall and impede drainage.

Other invasive species that are currently under quarantine in parts of Ohio include the Gypsy Moth, Walnut Twig Beetle, and Asian Longhorned Beetle.

Jurisdictions across Knox County have experienced significant effects from the EAB infestation. As diseased trees along rivers and streams have died, they have fallen into waterways, impacting drainage and the flow of water. Diseased trees along the public right-of-way have also impacted infrastructure, as they are more likely to fall during a storm or high wind event.

The county engineer and municipal street and road departments have aggressively removed diseased trees along the public right-of-way. This has been effective at reducing the impact on utility lines and other infrastructure but has been a significant financial burden for jurisdictions. Public agencies are also not able to remove trees from private property. Individual landowners are responsible for removing dead and diseased trees from their personal property. Because this does not always occur, there are still thousands of dead and diseased trees that will continue to cause problems across the county.

2.2.7 Land Subsidence/Landslide

Land subsidence is the gradual or sudden sinking of the Earth's surface caused by subsurface movement of earth materials. Subsidence is an issue that develops over time. The primary causes are aquifer-system compaction, underground mining, drainage of organic soils, natural compaction, sinkholes, and thawing permafrost. Land subsidence affects more than 17,000 square miles across the United States, an area equivalent to the size of New Hampshire and Vermont. For more than 80% of this area, subsidence is the result of groundwater exploitation and overuse.

Karst is a specific type of topography that can contribute to land subsidence issues. Karst is a landscape shaped by the dissolution of limestone or dolomite layers of bedrock. Surface water percolates through these layers, slowly dissolving the limestone or dolomite and creating voids. The voids may be visible or invisible, depending on their depth. Visible voids can allow surface water to flow directly into the water table. Deeper voids are not visible at the surface. Over time, the water table can change, potentially destabilizing the deeper voids. While karst topography is present in western Ohio, there is no known karst topography in Knox County.

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. Landslides can occur as a result of geological (weak, weathers, sheared materials), morphological (tectonic shift, thawing, vegetation removal), or human (excavation, deforestation, mining) causes. Water is the primary cause of landslides, generally due to intense rainfall or snowmelt. Seismic activity can also cause landslides.

Land Subsidence/Landslide Risk Assessment

The planning team considers land subsidence/landslide a low risk for Knox County. There are no known karst areas in the county and little known risk for sinkholes. The eastern portion of the county near the Mohican River features higher elevations and more rolling terrain than other areas of the county. Landslides are possible although not frequent in this area. The greatest concern identified in planning team meetings was the potential risk from uncapped wells. Over time, many property owners that use private wells as their water source have drilled new wells. Because there is no official process for capping an old well, there is no way to quantify these wells, identify their locations, or determine if they were properly capped. The health department is responsible for testing new wells but has no authority over old wells that are no longer in use. The planning team expressed concern over this issue and the possibility of

substances infiltrating the groundwater through these wells or possibly causing sinkholes or other safety concerns.

Local Land Subsidence/Landslide History
Planning team members do not report known incidents involving land subsidence or landslide. While there is some minor risk for land subsidence issues or landslides in certain areas of the county, there is no identifiable history of such incidents.

2.2.8 Severe Thunderstorm

A thunderstorm is a local storm produced by a cumulonimbus cloud accompanied by a combination of thunder, lightning, and hail. Lightning is a brief, naturally occurring electrical discharge that occurs between a cloud and the ground. Hail is frozen rain pellets that can damage buildings, vehicles, and other structures as they fall; it forms in the higher clouds and accumulates size as it falls as precipitation. If temperatures close to the ground are warm, the hail can partially melt or become freezing rain. Most thunderstorms include heavy precipitation and wind. These storms can produce hail, lightning, flash floods, tornadoes, and damaging winds that pose significant risk to people and property in the area. A thunderstorm that produces a tornado, winds of 58 mph or greater, and/or hail with a diameter of at least 1”, is considered a severe thunderstorm. These storms typically develop as part of a larger storm front and are preceded and followed by regular thunderstorms.

Severe Thunderstorm Risk Assessment
Thunderstorms occur frequently in Knox County, especially during the spring and summer. In these seasons, heat warms the atmosphere throughout the day, creating an atmosphere ripe for thunderstorms with hail, lightning, heavy rain and wind. Microbursts often include strong straight-line winds that can damage or destroy standing crops and develop quickly with little warning. Most thunderstorms include heavy precipitation, wind, and thunder. Hail and lightning are possible but less frequent. Thunderstorms are a countywide hazard and can affect all areas and jurisdictions. They range from minor to severe, although the most are minor. Thunderstorms are relatively frequent but generally result in limited property damage.

Even when minor, thunderstorms can damage property and infrastructure. Hail typically damages vehicles, roofs, and siding although injuries or loss of life are rare. Thunderstorm winds can damage standing crops, especially those at a vulnerable growth stage. Damage to crops can drastically reduce yields, causing significant or even extreme loss to farmers for that year’s crop.

Table 2-30 describes the overall vulnerability of countywide property to worst case severe thunderstorm damage, including hail, wind, heavy precipitation and lightning. Vulnerability estimates were calculated at 25% of the county’s property as a worst-plausible case scenario for widespread severe thunderstorm damage. This figure was based on input from the planning team and loss statistics from a variety of past incidents.

Table 2-30: Thunderstorm Scenario Vulnerability Analysis

Building Type	Number of Buildings	Exposure
Residential	4,702	$1,269,732,000
Non-Residential	1,153	$319,747,000
Critical Facilities	475	$132,058,000
Totals	*6,330*	*$1,748,537,000*

Local Severe Thunderstorm History

Thunderstorms are a frequent hazard in Knox County. According to NCDC records, the county has experienced more than 200 incidents since 1950. While thunderstorm occurrences are generally minor and cause little or no damage, a rare serious event can cause significant property damage. Collectively, thunderstorm incidents have caused more than $5,000,000 in property damage across the county.

Table 2-31: Knox County Severe Thunderstorm History

Hazard	Incidents	Property Loss	Crop Loss	Deaths	Injuries
Thunderstorm Wind	208	$5.89M	$10K	1	6
Hail	73	$210K	0	0	0
Lightning	2	$160K	0	0	0

While thunderstorms are common in Knox County and rarely cause significant damage, there are exceptions. One such exception occurred on August 26, 2003. In the evening hours, thunderstorm winds estimated to be as high as 70mph blew through Knox County. Trained weather spotters measured a gust of 60mph in Mount Vernon. The storm caused a significant number of trees to fall, more than 100 across the county. Homes in Mount Vernon and Centerburg were also damaged. The county experiences significant power outages and blocked highways due to debris. In total, property damage was estimated at $300,000.

On the afternoon of June 22, 2006, the central portion of Knox County was impacted by a severe thunderstorm event. In Fredericktown, significant damage to homes and many downed trees were reported; in Mount Vernon, several trees were downed and multiple houses damaged. Several locations in the county experienced downed utility poles and lines. Damages totaled $175,000 for this event.

The costliest thunderstorm event to impact Knox County occurred on June 29, 2012. During the afternoon, a derecho storm system developed over northern Indiana. As the system moved across central Ohio in the late afternoon, the storms intensified. Widespread damage was reported across much of central Ohio, including Hancock, Wyandot, Marion, and Morrow counties, as well as Columbus and portions of southeast Ohio. In Know County, wind speeds were estimated to be as high as 65mph. More than half of the county's residents lost power at some point during the event. It took several days for power to be restored to all parts of the county. Roads were closed and transportation impacted because hundreds of trees and many utility poles were downed in the storm. Dozens of buildings sustained significant damage, including lost roofing and siding. Property damage in Knox County totaled $1,400,000; the

county was ultimately included in a federal disaster declaration along with many other Ohio counties.

2.2.9 Tornado/Windstorm

Windstorms can include rotational or straight-line winds and can occur within a larger weather system or as an independent hazard. Rotational winds events are classified as tornadoes or funnel clouds while straight-line wind events are generally identified as windstorms.

A tornado is an intense, rotating column of air in the shape of a funnel or rope whose circulation is present on the ground. If the column of air does not touch the ground, it is referred to as a funnel cloud. Tornadoes usually range from 300 to 2,000 feet wide and form ahead of advancing cold fronts. They tend to move from southwest to northeast because they are most often driven by southwest winds. When a single storm system produces more than one distinct tornado or funnel cloud, it is referred to as a tornado outbreak.

Tornado magnitude is measured using the Enhanced Fujita scale, abbreviated as EF. The ratings range from EF-0 to EF-5 and are based on wind speeds and related damage. The Enhanced Fujita Scale has been used as the official tornado rating scale since 2007. Prior to 2007, tornado severity was rated using the Fujita Scale (abbreviated as F-0 through F-5). The difference between these two rating scales is that the Enhanced Fujita scale bases the rating on wind speed while the earlier Fujita scale is based on the amount of destruction.

The following table is provided by FEMA and indicates the type of damages typically caused by a tornado according to the Enhanced Fujita Scale.

EF-Scale	Wind Speed	Typical Damage
0	65 – 85 mph	Light damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
1	86 – 110 mph	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
2	111 – 135 mph	Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted.
3	136 – 165 mph	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trees debarked; heavy cars lifted off the ground and thrown.
4	166 – 200 mph	Devastating damage. Whole frame and well-constructed houses completely leveled; cars thrown and small missiles generated.
5	>200 mph	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters; high-rise buildings have significant structural damage.
No rating		Inconceivable damage. Should a tornado with the maximum wind speed in excess of EF-5 occur, the extent and types of damage may not be conceived.

A windstorm is a weather event with very strong winds but little to no precipitation. Sustained wind speeds in a windstorm can reach at least 34 mph with gusts significantly higher. Regardless of wind speed, any wind event that causes property damage can be considered a windstorm.

A derecho is a widespread, long-lived windstorm. It is often associated with bands of rapidly moving thunderstorms. This type of storm can produce damaging straight-line winds over extremely large areas, sometimes spanning hundreds of miles. To be classified as a derecho, the storm must produce damage over at least 250 miles, have wind gusts of at least 58 mph across most of the storm's length, and multiple gusts of 75 mph or greater. The destruction produced by a derecho can be very similar to that of a tornado but generally occurs in one direction along a straight path.

Tornado/Windstorm Risk Assessment

In Ohio, tornadoes are typically narrow and do not reach width of the mega-tornadoes that occur in the Great Plains and southern states. Locally, tornadoes are typically 25-500 yards wide and stay on the ground for a few miles. Ohio ranks among the top twenty states in injuries, fatalities, and property damage from tornado events. Tornadoes are not a frequent occurrence in Knox County but can have a significant impact when they do occur. The magnitude of past tornadoes has ranged from F/EF0 to F/EF2. Tornadoes are a countywide hazard and can affect all areas and jurisdictions.

The lightly rolling topography of central Ohio is vulnerable to damage from high wind incidents, making windstorms a countywide hazard that can affect all areas and jurisdictions. Most severe wind events are part of larger storm systems that typically include heavy rain, hail, ice, snow, or thunderstorms. Extreme winds can also occur independent of other hazards.

Property damage from tornadoes and windstorms can include damaged roofs, gutters, downspouts, and trees. Outbuildings, barns, and storage buildings are at risk for damage because these structures are less resistant to wind damage and are frequently built on concrete slabs or dirt foundations. Damage to agriculture during the growing season when fields are planted is also a risk. High winds can damage crops and reduce yields, leaving a negative impact on the local economy.

Most residential structures in the county are constructed from wood, concrete, brick, or stone. Older homes typically have limestone or other masonry materials and are built on traditional foundations with basements or crawl spaces. Newer residential structures are often built on concrete slabs with no basement. These homes are prone to superficial damage, roof damage, and falling trees during wind events. Mobile homes are more vulnerable to wind damage because they are less secured to the ground that buildings with foundations and are constructed of less wind-resistant material than traditionally built homes.

Table 2-32 describes the overall vulnerability of countywide property to worst case tornado and wind damage. Vulnerability estimates were calculated at 10% of the county's property as a

worst-plausible case scenario for widespread tornado or windstorm damage. This number was based on input from the planning team and loss statistics from a variety of past incidents.

Table 2-32: Tornado/Windstorm Scenario Vulnerability Analysis

Building Type	Number of Buildings	Exposure
Residential	2,181	$778,039,000
Non-Residential	692	$191,849,000
Critical Facilities	285	$79,234,000
Totals	*2,798*	*$1,049,122,000*

Local Tornado/Windstorm History

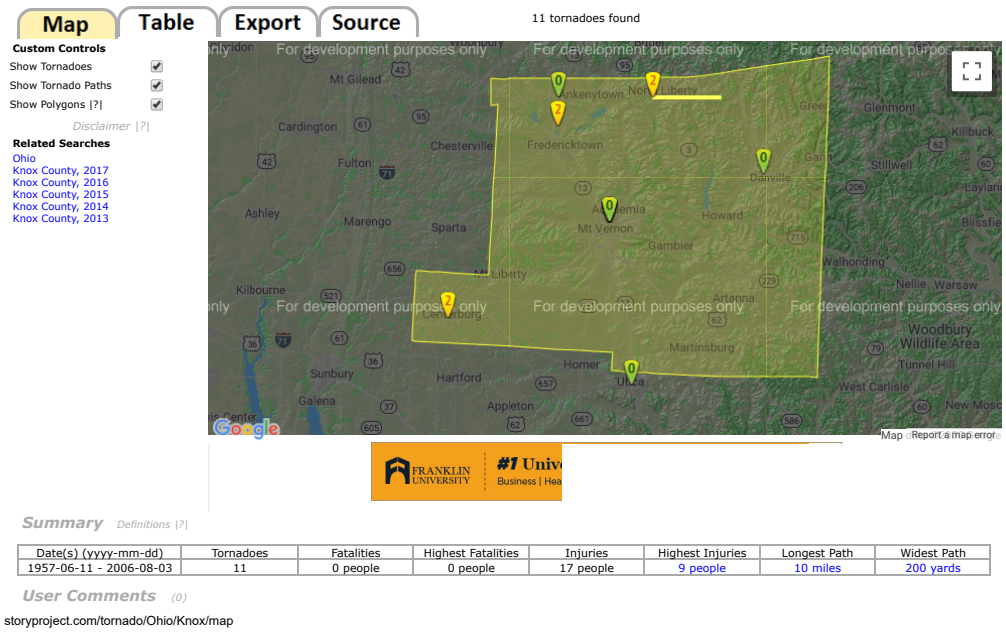
Knox County has experienced 11 tornadoes according to NCDC records. Most of these have resulted in limited property damage. The county's 31 high wind events have caused considerably more property and crop damage.

Table 2-33: Knox County Tornado/Windstorm History

Hazard	Incidents	Property Loss	Crop Loss	Deaths	Injuries
Tornado	11	$1.54M	$35K	0	17
High Wind	31	$5.73M	$760K	0	0

The following map identifies the location of tornado incidents in Knox County.

Map 2-6: Tornado History



Two of the strongest tornadoes to impact Knox County occurred in 1982. On March 31, 1982, an F2 tornado touched down in Mount Vernon. The storm destroyed four homes and heavily damaged seven; total damages were $250,000. Four people also received minor injuries. Just

three days later, another F2 tornado touched down in Fredericktown. This storm caused another $250,000 in damages, destroying two mobile homes and one frame home and damaging several other buildings. Nine people reported minor injuries from the tornado.

The most recent tornado in Knox County occurred on August 3, 2006. During the late afternoon, a F0 tornado touched down on the west side of Mount Vernon along State Route 13. Four businesses, including a lumberyard and car dealership, were damaged. At the car dealership, one employee sustained minor injuries and flying debris damaged at least a dozen vehicles. According to witnesses, the tornado was on the ground for several hundred feet and created a damage path approximately 50 feet wide. Total property damage from the incident was $325,000.

The most severe non-tornado wind event to impact Knox County occurred on September 14, 2008. On that day, the remnants of Hurricane Ike moved northeast from Missouri across the Midwest and Ohio. In the afternoon hours, wind gusts as high as 70mph occurred in many areas of Ohio. Knox County suffered extensive property damage as thousands of trees and utility poles were downed by the extreme wind. Property damage to hundreds of homes ranges from a few missing shingles to major structural damage. Falling tree limbs and debris also damaged a significant number of vehicles. Across the county, roads and streets were closed because of downed trees and utility poles, making travel difficult for several days. Widespread power outages impacted much of the county, with some residents without power as long as ten days. Schools and universities were forced to close because of power outages and property damage. Because the storm occurred in the early fall before fields had been harvested, farmers suffered significant damage to their crops. Corn yields were reduced by three to five percent in many areas; soybean crop yields also suffered, but not as significantly as corn crops. In all, Knox County suffered $4,000,000 in property damage and $750,000 in crop damage. Across all of northern Ohio, damages exceeded $300,000,000 from this event. Knox and many other counties received a federal disaster declaration to assist in recovery from this storm.

2.2.10 Water Quality Emergency

Water quality refers to the chemical, physical, biological, and radiological characteristics of water. It is a measure of the water relative to the requirements of one or more biotic species and human need or purpose. A water quality emergency occurs when the quality of water available for human consumption is compromised. In recent years, water quality has become a growing concern in Ohio as Lake Erie and its associated rivers and streams have been affected. Several areas of the state have also experienced water quality issues in inland lakes and reservoirs, making water quality a growing concern. Algal blooms are one of the more common causes of water quality issues. Algal blooms occur when colonies of algae grow out of control and produce toxic harmful effects on people and animals. In Lake Erie, high phosphorous levels caused by runoff are considered a contributing factor to these harmful algal blooms. Some algal blooms produce microcystin, which is a poisonous bacterium that can sicken or kill people, fish, birds, and other animals. When microcystin or other toxins infiltrate a public water supply, the water becomes contaminated and unsafe for consumption. These incidents can have a drastic human and economic toll on the affected area.

In addition to harmful algal bloom risk, water treatment and distribution systems are susceptible to infrastructure failure. This can include anything from long-term lack of repair, maintenance and/or upgrade to contamination from lead pipes and other substances.

Water Quality Emergency Risk Assessment

Because a water quality emergency can occur in any source body of water or water treatment facility, water quality is a countywide hazard that can affect all areas and jurisdictions. When water quality is compromised, risks to the community include public health and the economy. From a public health perspective, contaminated water can cause serious illness when consumed. Persons with special medical needs, compromised immune systems, the elderly, and children are most susceptible to this. Animals, including family pets and livestock, are also susceptible to illness from contaminated water. If the water supply is contaminated, residents lose access to drinking water in their homes; the ma ny businesses that use water in their regular operations are forced to close until water service is restored. Retail and service businesses may be affected if the public travels to other communities for shopping and food service needs during the emergency. This revenue loss, even if only for a short duration, can have a significant economic impact. Businesses lose critical revenue which quickly leads to reduced wages for employees. The longer the emergency lasts, the more significant the economic impact. Any compromise in the water supply also affects the public's trust of government officials. If the public is concerned about the safety of their water and doesn't feel local officials are fully communicating about the issue, they may question the information provided by local officials.

To protect the community's water supply, jurisdictions must continually monitor, repair, and upgrade water treatment infrastructure. Because this is costly, jurisdictions must plan and budget for it. If the infrastructure is not well maintained and emergency work is necessary when a water quality emergency occurs, the economic cost is higher than if work is completed as part of ongoing maintenance and upgrades. In addition to the direct economic loss, the jurisdiction must immediately identify funds to make the repairs. These costs are often recouped through increases in the fees charged to consumers, ultimately costing residents more money through water rates, user fees, and local taxes.

Local Water Quality Emergency History

The most significant water quality emergency in Ohio occurred on August 3, 2014.While this incident had no direct impact on Knox County, it garnered national attention and forced municipalities statewide to consider the impact a similar situation would have on their community. On August 3, the water treatment plant for the city of Toledo in northwest Ohio detected microcystin from a toxic algal bloom in their water supply and declared the water unsafe to drink. The Toledo water system supplies municipal water to approximately 400,000 people in the northwest Ohio region. Local emergency management and government officials rushed to provide drinking water to the affected communities. Within hours, stores across the region sold out of bottled water as residents traveled across the region to purchase critical water supplies. Restaurants and food service businesses were forced to close until safe water could be provided and hospitals experienced a surge of patients who believed they were ill

from consuming contaminated water. Within three days, Toledo's water was declared safe to drink but the economic and political ramifications lasted much longer. More than five years later, municipal governments in the region are still working to address critical improvements to water treatment infrastructure and identifying alternate water sources.

Communities in Knox County have not experienced a similar water crisis but there is concern about protecting the local water supply. Most communities use groundwater for their public water systems, as do the many homes with private wells. This water is susceptible to surface contamination. In other areas of Ohio, inland lakes and reservoirs have experienced toxic algal blooms and other water quality issues. Knox County has several inland recreational lakes that could be impacted by a similar situation. Throughout Ohio, research is underway to determine the root cause of the increase in toxic algal blooms and other water quality issues and identify actions that can be taken to reduce their occurrence.

2.2.11 Winter Storm

A winter storm is a weather event that includes several winter weather hazards and can develop anytime between late fall and early spring. These storms can include any combination of extremely cold temperatures, wind, snowfall, sleet, ice, rain, or freezing rain. These severe winter storms are frequent in Ohio but the specific components of each storm depend on the weather conditions at the time. Winter temperatures can be mild and relatively warm (above freezing), or they can fall below zero and stay there for several days. A winter season may include several fluctuations between cold and warm spells or be relatively constant.

A blizzard is a specific type of winter storm characterized by sustained winds or frequent gusts of 35 mph or greater and falling or blowing snow that reduces visibility to less than ¼ mile; both of these conditions must be present for at least three hours to be considered a blizzard.

A non-blizzard severe winter storm often begins with warmer air followed by very cold temperatures and heavy precipitation. An initial blast of warm air can cause temperatures to hover at the freezing point as precipitation falls, causing ¼ "to ½" ice (or more) to form on roads, trees, electrical lines, gutters and roofs, and vegetation. The precipitation starts out as freezing rain and/or sleet and, as the temperatures drop, turns to snow that adheres to the ice and forms heavy clumps that bring down power lines and trees. As the storm system moves through and winds kick up, temperatures drop and the heavy falling snow drifts across roads, ice damages trees and buildings, and road conditions becomes treacherous. This type of storm can drop several inches of heavy, wet snow across the county.

Another type of severe winter storm that can affect Ohio begins with extremely cold weather (below 10 degrees Fahrenheit) and heavy snowfall, high winds, and extreme cold. A severe storm of this nature would likely pack sustained winds of 15-25 miles per hour, over ten inches of snow, and temperatures below ten degrees Fahrenheit for more than 24 hours. This kind of storm can easily deposit a foot or more of snow and disrupt daily activities for several days. Because the ice is not part of this kind of storm, damages are generally less as power lines are not destroyed and structural damage is not severe. However, the amount of snow is challenging

in light of the extreme low temperatures. The snow tends to be fluffy and creates deep snowdrifts and blocks roads.

Ice storms are another type of winter storm event that can impact the area. An ice storm occurs when damaging ice accumulations occur during freezing rain situations. The accumulated ice can cause trees and utility lines to come down, resulting in loss of utilities and communications systems. As ice accumulates on roadways, travel also becomes dangerous. A significant ice accumulation is considered anything ¼ “or more.

Winter Storm Risk Assessment
Severe winter weather is a risk across all of Ohio. Winter storms range from short, mild bursts of snow and ice to multi-day events incidents with significant snowfall. In Knox County, winter storms are a countywide hazard and can affect all areas and jurisdictions.

Winter storms often include multiple hazards, such as ice and snow. Ice accumulates as temperatures fall then turns to snow, creating a dangerous layer of snow-covered ice, increasing the potential for vehicular accidents. Road crews work continuously to clear roadways. Occasionally, ice storms occur independent of other winter weather hazards. Although rare, when this occurs it can have a significant negative effect on the community. Power outages are a frequent outcome of ice storms when precipitation accumulates on trees and power lines causing them to break. Extremely cold temperatures can also occur without other accompanying winter weather hazards, although this is infrequent. These incidents are typically very short, lasting only a day or two, and are an inconvenience to residents and businesses more than the direct cause of property loss.

The greatest risk from winter storms is the loss of utilities. Power outages can occur during ice storms or winter storms that include significant wind or snowfall. Because most electric lines are above ground, they are vulnerable to damage from wind and ice. While many electric providers have improved their distribution systems in recent years and new construction generally includes underground utilities, the main transmission lines are still above ground and vulnerable to weather-related damage. In spite of this, power outages are infrequent and generally not widespread outside of an extreme ice event.

Anticipated losses from winter storms include content loss, such as food and perishables due to power interruptions, and minor economic loss due to short-term business closures. Except for the extreme but rare blizzard, loss of residential and commercial structures or infrastructure is not expected. Most winter storms are a short-term inconvenience that make residents uncomfortable but last for a few hours up to several days. Casualties are extremely rare, with the exception of traffic accidents resulting from dangerous road conditions.

Table 2-34 describes the overall vulnerability of countywide property to worst case winter storm damage. Vulnerability estimates were calculated at 2% of the county’s property as a worst-plausible case scenario for widespread winter storm damage. This number was based on input from the planning team and loss statistics from past incidents.

Table 2-34: Winter Storm Scenario Vulnerability Analysis

Building Type	Number of Buildings	Exposure
Residential	376	$109,739,000
Non-Residential	92	$25,580,000
Critical Facilities	38	$10,565,000
Totals	*506*	*$139,884,000*

Local Winter Storm History

Knox County has experienced 19 winter storm-related incidents since 1950, according to records maintained by NCDC. While most of these incidents have been minor, some have caused significant property loss.

Table 2-35: Knox County Winter Storm History

Hazard	Incidents	Property Loss	Crop Loss	Deaths	Injuries
Blizzard	0	0	0	0	0
Extreme Cold/Wind Chill	5	0	0	0	0
Ice Storm	3	$6.87M	0	0	0
Winter Storm	19	$757.89M	0	0	2

One of the more costly and disruptive winter storms to impact Knox County occurred on December 22, 2004 when a winter storm dropped eight inches of snow, one inch of ice, and freezing rain on Knox and surrounding counties. Because of the significant ice accumulation on roads and power lines, widespread power outages were reported. Travel was nearly impossible for several days after the storm because of the downed trees and lines. The snow and ice caused treacherous road conditions, leading to hundreds of accidents. Because the storm occurred only a few days before the Christmas holiday, the disruption to businesses and residents was significant. In total, the county suffered $5,400,000 in property damage from the storm.

Just two weeks after the Christmas 2004 storm, Knox County was again impacted by a significant winter weather event. A prolonged period of freezing rain caused significant ice accumulation between the early morning hours of January 5, 2005 and the morning of January 6. By mid-day, temperatures warmed enough to turn the precipitation back into rain, but significant damage had already been done. Widespread power outages were reported after ice accumulated on utility lines. Some areas experienced basement flooding when sump pumps could not function due to loss of power. Across the state, clean up and repair costs soared into the millions. Most counties impacted by the event experienced damages greater than $1,000,000; some counties exceeded $10,000,000, making the damages from this event among the highest for any natural disaster ever recorded in Ohio. In Knox County, damages exceed $6,800,000.

Much of the county experienced extreme cold and snow in the winter of 2014. Knox County was no exception. Along with most of Ohio, Knox County suffered through one of the coldest

and snowiest winters the state had experienced in several decades. The first extreme cold snap of the season occurred on January 6, 2014 and lasted for several days. Knox County Airport reported a low temperature of -11°F on both January 6 and 7. The cold front was accompanied by wind speeds of 25 to 35mph and gusts up to 45mph. By mid-day on January 6, wind chills dipped as low as -25°F and stated at or below that level for 24 hours. All local schools and some businesses were closed both days. The county again experienced an extreme cold snap on January 28, 2014. Wind chills dropped as low as -30°F during the early morning hours. Low temperatures in the region tied previous lows set in 1977. By late morning, temperatures in most areas had recovered to the low single digits. As with earlier in the month, most local schools were closed on January 28 and 29 as well. While property loss is not associated with this event, the economic impact was significant as businesses were forced to close for several days throughout the event.

2.3 VULNERABILITY ASSESSMENT

This section addresses each jurisdiction's vulnerability to the identified hazards. Information for this section was provided through direct feedback from planning team members and research.

2.3.1 Knox County

Knox County stakeholders identified infrastructure failure as their hazard of primary concern. People across Knox County rely on critical infrastructure, including roads and bridges and utility systems, for daily life. If any of these services are compromised or unavailable, the impact on the community will be felt immediately. Utility infrastructure includes water, wastewater, and stormwater systems as well as electricity and natural gas. Most water, wastewater, and stormwater utilities are provided through municipal systems. Electricity and natural gas systems are managed and maintained by private companies. In unincorporated areas, many homes utilize water wells and individual septic systems for water and wastewater. Because of the significant expense to maintain and improve these systems, many communities struggle to keep pace with community growth and evolving regulatory requirements. The same challenge applies to transportation infrastructure. Roads and bridges are maintained by a combination of state, county, and municipal government entities. These organizations continually work to improve roadways and perform necessary maintenance but keeping up with the damage caused by general use and natural hazards is difficult. Dams are a specific type of infrastructure that are a concern for Knox County. Across the county, there are 57 dams. While many of these are class IV dams that pose little or no risk to the community, there are numerous Class I and II dams that are a more significant hazard. These dams are maintained by the owners, which include state and federal agencies as well as private owners. Maintenance of these class I and II structures is critical because many are located in populated areas. These adjacent communities could be at risk in a major dam failure. While none of these dams have failed in the past, it is a concern for the county.

Flooding was rated as the county's second most concerning hazard. Knox County is part of the Muskingum River Watershed; water in the county ultimately flows south to the Ohio River. The watershed begins in Morrow County as the North Branch of the Kokosing River and winds into Knox County, through Fredericktown, and into Mount Vernon where it joins the Kokosing River. The Kokosing then winds to the southeast through Gambier and into Coshocton County. The Mohican River winds from north to south on the eastern boundary of Knox County. The Kokosing and the Mohican join just east of Knox County to form the Walhonding River, a major tributary of the Mohican River.

While Knox County is vulnerable to flash and riverine flooding, flash flooding is considered a much greater threat. Developed areas, including Mount Vernon and Apple Valley, can experience significant short-term flash flooding in low lying areas because storm sewers are not sufficient to manage runoff as quickly as precipitation falls. As these communities have experienced residential and commercial development, this issue has continued. Several villages, including Fredericktown and Gambier, can also experience these flash flooding incidents. Floodwaters generally drain within a few hours of the precipitation event but the long-term

damage to streets, roads, and infrastructure is a financial hardship for the county and each impacted jurisdiction. Because of the county's rolling topography, flash flooding can also occur in low-lying areas in the unincorporated parts of the county. These areas feature farmland and natural habitat areas so there is little direct impact on structures and buildings. Roadways can become flooded but this is typically very short lived, with water draining within several hours of the event.

The risk of riverine flooding that interferes with threatens life and property across Knox County is moderate. When rivers and streams do leave their banks, the flooding is generally short lived. Structures are rarely impacted but roadways, including several key state highways, can be closed temporarily. These road closures create significant hardship for residents in the more remote areas of Knox County who travel to Mount Vernon and other cities for work, school, and business purposes.

Knox County is vulnerable to severe storms, including tornado/wind events, severe thunderstorms, and winter storms. Wind and thunderstorm incidents occur multiple times per year but are rarely severe and cause only limited damage. Tornadoes can be extremely damaging but are very rare. Winter storms also occur at least once per year but are generally brief and cause minor inconvenience rather than significant property damage or injury and loss of life. In the most serious incidents, wind from any of these storms can damage structures, cars, trees, and utility poles. Debris can become a challenge that requires coordination among multiple agencies to manage. Small and narrow county roads can be blocked by debris. Bridges and culverts that are old or in ill repair, or that are simply low-lying in a riverine setting, can be washed out or compromised easily. The greatest risk to residents, however, is the power outages that often follow these storms. Brief power outages of several hours are manageable but outages that last overnight or for several days can be a huge challenge. People depend on power for basic services, healthcare, and critical communications. In adverse weather conditions, including heat and cold weather extremes, people are more vulnerable from lack of power.

Hazardous materials were identified as a risk because of the number of roadways that traverse Knox County, including multiple state highways. Commercial vehicles frequently travel through the area on state routes 13, 36, 62, 229, and others. Many of these vehicles transport hazardous materials either through the county or to and from the industrial facilities located within Knox County. Several pipelines also traverse the county, primarily for gas transmission. Exposure to hazardous materials via rail is limited because there is only one rail line in the county.

Drought and extreme heat rated seventh on the list of Knox County hazards. While droughts have occurred in the past, they are generally rare events. The most significant impact in a drought is on the county's agricultural industry. Crop yields can be greatly reduced during any given growing season under drought conditions. While many farmers purchase crop insurance, this can only somewhat limit the financial impact of a drought. Livestock operations are also impacted during a drought when the price of grain and feed increases. In the most extreme and

prolonged drought conditions, adequate water supply could become an issue. However, because groundwater is the primary water source for communities across Knox County, it would take a drought of extreme significance for this to become a concern. Excessive heat, while rare, is also a concern due to the impact on the human and animal population. Heat adversely affects the elderly, young children, and people with medical conditions. If a power outage were to occur during an extreme heat event, additional resources would likely be necessary to support these populations for the duration of the event.

Knox County has not been impacted by invasive species with much frequency but the hazard was identified as a concern because of the potential impact on trees and vegetation. As occurred with the Emerald Ash Borer infestation in the 2010s, dead and diseased trees pose a huge challenge for local governments and property owners. As these trees are weakened by the disease, they are more vulnerable to wind damage and significantly increase the debris field and clog waterways during wind and flood events. Knox County has many wooded and tree covered areas so another infestation could be devastating to the county's natural habitats.

Water quality was ranked ninth on the list of county hazards. The planning team felt that the county's water supply was plentiful and safe. Groundwater is the primary source for water in the county, both for public water systems and private wells. The planning team reported no prior issues with quality of the water, although they recognized that this is a growing issue across the state and could become a more significant concern in the future.

Land subsidence/landslide and earthquake were rated as the lowest priority hazards and are considered minimal risks in the county. The county has a few isolated areas along the Mohican River on the edge of the county that could experience minor landslides. This area is steeper and has more rolling topography than the rest of the county. Landslides are possible in this area but there is no known history of their occurrence. The county has no known karst structures. There was some discussion among the planning team about concern over old water wells that may not have been properly capped when taken out of service. The quantity and location of these wells are unknown but they are considered a minor risk. Earthquake is considered a very low risk. There is no history of earthquake occurrence in the county. Underground utilities and infrastructure would be the greatest risk should an earthquake of any significant magnitude occur.

2.3.2 Centerburg

Centerburg is located in the far southwest corner of Knox County. Because of its proximity to the greater Columbus region, Centerburg and the surrounding townships are experiencing more rapid development than other areas of Knox County. In part due to this development, Centerburg officials identified infrastructure failure as their top concern. Like many small jurisdictions, Centerburg is continually working to maintain roadways and public utilities with limited resources. Officials are considering a stormwater utility to fund maintenance and improvements to that system. Water treatment and distribution has recently been transitioned to Del-Co Water after being managed directly by the village for many years. Stormwater is an ongoing issue as the village attempts to keep pace with community growth and as precipitation

events bring more rainfall over a shorter period of time. The village's stormwater system needs to be expanded to accommodate increased precipitation and additional structures but the cost of this project presents a financial challenge to the village. Transportation infrastructure is also a concern. State Route 36 runs through Centerburg; as the primary route between Mount Vernon and Columbus, this road is heavily traveled by passenger vehicles and commercial traffic. The village works diligently to maintain roads and bridges but as the community grows, this will become a greater strain on the local budget. According to the village's 2018 street inventory, 30% of village roadways are in poor condition. This is a significant financial challenge for the village as they have a limited budget to dedicate to street maintenance and replacement. There are no dams or levees within Centerburg.

Flooding was identified as the village's second concern. According to local officials, flooding incidents have increased in the last five to ten years. Flash flooding is the primary concern as streets and storm sewers become overwhelmed in excessive, rapid rainfall. While roads are generally only impacted for a few hours, this creates travel challenges for residents and causes excessive wear and tear on roadways. Basement flooding is very common across the village in these events. A very limited number of residential structures experience flooding in the living areas. These structures are located in the floodplain but are thought to no longer have active flood insurance policies. Riverine flooding can be an issue in prolonged precipitation events but this is very rare.

Tornado and wind events were ranked as the village's third hazard. Centerburg has significant tree cover and is therefore vulnerable to damage from straight-line and rotational winds. While the village works diligently to maintain trees on public property and encourages residents to do the same on private property, downed trees are still a significant risk. Limbs and branches can damage structures or vehicles and break utility lines. If this causes a widespread or prolonged power outage, the village will be challenged to meet the needs of residents. AEP, the village's electric provider, has trimmed or removed many trees and stabilized the village's power. In a serious wind event that impacts the greater region, the village is still likely to experience an outage that could take several days to restore.

As with wind events, the potential impact on the power supply is the primary concern for severe thunderstorms and winter storms. These hazards were rated as Centerburg's fourth and fifth hazards, respectively. Severe thunderstorms occur somewhat frequently during the year but are generally minor. In the event of a serious storm, the impact on the community can be just as severe as a tornado event, including widespread power outages. In winter storms, ice is the greatest concern. Snowfall is an inconvenience to residents and businesses but is generally only a problem for a brief period of time. If a winter storm involves ice, however, power outages are a significant concern.

Centerburg officials considered drought/extreme heat and invasive species to be minor risks for the village. Drought is extremely rare and generally does not directly damage structures. Limitations on the water supply and impact on residents are the greatest concern. The risk from

invasive species is primarily from long-term damage to trees and vegetation. Dead or diseased trees are more vulnerable to wind damage and can clog waterways, increasing flooding.

Water quality was considered a minor hazard for the village. Centerburg recently transitioned their water treatment and distribution process to Del-Co Water, a large regional water provider. Combining the water system with a larger organization will make maintenance and system upgrades more efficient and affordable. Village officials report no prior incidents of compromised water quality although they recognize the potential for this issue to occur and the impact it would have on the community.

Hazardous materials spills are a concern for Centerburg given the increasing amount of commercial and passenger traffic that travels through the village on a daily basis. Many of the commercial vehicles carry some type of hazardous substance. Because State Route 36 runs through the center of the village, the village would be directly impacted in an accident. Despite the level of risk, this has not happened frequently in the past.

Along with the rest of the county, land subsidence/landslide and earthquake were considered minimal risks for the village.

2.3.3 Danville

Danville is a rural community in the northeast quadrant of Knox County. The East Branch of Jelloway Creek runs through town. Local officials identified infrastructure failure as their primary concern. The village maintains public utilities for water, wastewater, and stormwater. Some areas of town experience a significant number of water line breaks; the lines are old and should be upgraded but this project is cost-prohibitive for the village without external funding support. Danville recently mapped all of the wastewater system lines as an initial step to upgrading the system. The storm sewer system does not cover the entire village and should be expanded. Power outages are another utility concern. Upgrades to the village's power system in recent years have reduced outages. While local officials feel their electric utility is strong, an outage that impacts all or most of the village for several days is a significant concern. Loss of power would disrupt communication, worsen medical conditions of residents, and create significant hardship across the community. Transportation infrastructure is also a concern for village officials. Roads and bridges are subject to ongoing damage and wear from the effects of water and heavy use. Maintaining and upgrading roadways as needed is a challenge with the village's limited financial resources. There are no dams or levees in Danville although there are several in the vicinity of the village.

Flooding is another top concern for local officials. The village is susceptible to riverine flooding when Jelloway Creek leaves its banks and flash flooding during heavy precipitation events. Flash flooding is more common than riverine flooding and contributes to more damage to buildings and infrastructure. While there are no dams within Danville's village limits, the dams downstream in Coshocton County can cause water to back up towards Knox County. In extreme flood events, these floodwaters can backup all the way to Danville and block State Route 62, the primary transportation route through the village.

Tornado/windstorm, severe thunderstorm, and winter storm were ranked as the next most concerning hazards. The common thread between these incidents is the risk to Danville's power supply. Any high wind event that disrupts electricity will cause hardship for residents and businesses in Danville. Tornadoes are not a frequent occurrence but officials report that independent high wind events have increased in recent years. Thunderstorms occur frequently but are generally mild. The rare extremely severe thunderstorm can cause significant damage to structures and vehicles throughout the village. Winter storms are generally a temporary inconvenience. The exception to this is when a winter storm involves ice. Ice storms can cause significant property damage and lead to major power outages. If power restoration takes several days, which is not uncommon for rural communities if the event is widespread, residents will require assistance with sheltering and basic needs for the duration of the outage.

Hazardous materials are a concern because of the commercial traffic that travels through Danville on State Route 62. Many of these commercial vehicles haul diesel fuel and other hazardous substances. As the highway turns through town, the risk of an accident and spill increases.

Like the rest of Knox County, Danville considers drought/extreme heat to be a minor risk. While droughts can occur and have in the past, they are very infrequent. When they do occur, their first impact is the agriculture industry as crop yields are reduced. Within the village, the impact would be less direct. Residents, especially those with medical needs, could suffer during extreme heat but it is unlikely that property damage would be incurred.

The risk from invasive species relates to the impact on trees and vegetation. If any species were to damage trees, those trees would be more likely to fall during storms and wind events. This increases the village's risk for property damage and clogs streams and waterways, which contributes to increased flooding. Dead and diseased trees are costly to remove so any significant tree damage would strain the village's finances.

Danville officials consider water quality to be a minor risk. The village's water treatment system is in need of upgrades to improve the distribution process but the quality of the water distributed is not a concern. The village has access to a plentiful groundwater supply and has not experienced any problems in the recent history. Land subsidence/landslide and earthquake were also considered very low risks for Danville.

2.3.4 Fredericktown

Fredericktown is located in the northwest section of Knox County along the North Branch of the Kokosing River. Village officials cited infrastructure failure and flooding as their two primary hazards of concern. The biggest risk related to infrastructure failure is power outage. A widespread power outage that lasted multiple days would create significant hardship for the community, particularly in extremely temperatures. The village is in the process of separating their sanitary and stormwater systems. The eight of twelve project phases have been completed. The separation was necessary to meet current regulations and to provide better stormwater management for the village. The combined system was very easily overwhelmed by

heavy precipitation events. The current separation work has reduced this problem significantly but more work remains. The village's streets and bridges are also an infrastructure concern. These structures are continually damaged by water and general use. In flash flood events, some streets are routinely closed for up to 24 hours until water recedes. Dam failure is also a significant infrastructure risk. Knox Lake and Kokosking Lake are located north and northwest of the village; both of these man-made lakes have class I dams. The dams are maintained by the Ohio Department of Natural Resources and the Army Corps of Engineers. While they are considered structurally sound dams, there is risk to Fredericktown. If either of these dams were to experience a failure, the north end of the village would flood. This neighborhood includes single family homes, mobile homes, a public park, and multiple businesses. While dam failure is not likely, the impact could be significant should it occur.

Flooding is another significant issue for Fredericktown. The village is prone to flash flooding when storm sewers are overwhelmed in heavy precipitation events. Some streets can be closed for up to 24 hours after one of these events. Residential structures in the north section of town can experience basement flooding. A large mobile home park in this neighborhood also experiences significant flooding. This flooding is not believed to impact the first floor living space of these structures but there is concern that could happen in the future. Village officials discuss flooding from two perspectives: community and operations. They are first concerned with supporting residents during these events and preventing damage to their homes and properties. Additionally, they are concerned about being able to perform essential government functions, including police, fire, and EMS services. Riverine flooding is also a risk for Fredericktown. The village is located along the North Branch of the Kokosing River and not far from the Kokosing River main branch. When these rivers or their tributaries and streams rise and leave their banks, roads and properties can quickly flood. This happens much less frequently than flash flooding but is still a concern for village officials.

Tornado/wind storms, severe thunderstorms, and winter storms were rated three, four, and five on Fredericktown's hazard ranking. The common thread between these incidents is the potential impact on the population from power outages. Tornadoes and wind storms can cause significant property damage, depending on the severity. According to local officials, straight line winds are more common and cause more damage than tornadoes. They can create significant debris, which is an operational and financial challenge to clean up. Severe thunderstorms are fairly frequent, occurring multiple times every year, but generally very mild. The occasional storm that is extremely strong can cause property damage and downed trees. With winter storms, the greatest risk is ice. Snowfall events, even when the totals are significant, are mostly a temporary inconvenience to residents. When the event include ice, however, power lines can be damaged, trees and branches can fall, and the impact on the community is much greater. If power is compromised, the situation quickly becomes very challenging for residents.

Hazardous materials incidents are concern for the village because of the substances transported through the area on state routes 13 and 95 and other local roadways. Some industrial facilities in the area also store and use hazardous substances in their facilities. There

is some risk for vehicle accidents and industrial spills that could impact the community and waterways.

Drought/extreme heat and invasive species were rated as moderate risks for Fredericktown. Droughts and heat waves are rare. When they do occur, there is generally very limited damage to actual property. Extreme heat is a challenge for the population, especially those with medical needs. If the heat event compromises the power supply, the impact on the community would be greater. Invasive species is a risk because of the long-term impact on trees and vegetation. A tree disease that creates hundreds of dead or diseased trees that must be removed creates a significant financial burden for the village. During wind events, these weakened trees are more likely to cause damage to property and power lines. They also fall into creeks and streams, which increases the risk for flooding.

Water quality was rated as a minor risk for Fredericktown. The village's greatest issue with the water system is the need to upsize the lines to serve fire hydrants. The water supply itself is plentiful and is not thought to be a significant risk. Land subsidence/landslide and earthquake were also considered very low risks, ranking tenth and eleventh on the village's overall list.

2.3.5 Gambier

Gambier is a small community located just east of Mount Vernon. Kenyon College is located in the village and is the primary employer and business in the community. Like other communities in the county, Gambier identified infrastructure failure as their greatest concern. Power outages are their greatest infrastructure concern. There are few generators in town, including at the college. In an extended power outage, the village's 800 residents and the nearly 1,700 college students would be impacted. The village has worked diligently to maintain and upgrade their water, wastewater, and stormwater systems. As a small village, there is limited transportation infrastructure to maintain. The village does its best to repair and replace roads and bridges with limited resources. Increasing precipitation amounts and continual freeze-thaw cycles make that difficult and result in additional wear and tear on the roadways. There are no dams or levees in the village.

Local officials identified flooding as their second concern. Flash flooding is the most common type of flooding in Gambier. In heavy precipitation, the water rushes down the hill to the lower elevations at the edge of town. While most of this water drains away without issue, there are several low-lying areas where water collects. In one area, there are several small homes that can become surrounded by floodwater. Some roadways become impassible in these events; the village attempts to deploy high water signs to warn motorists but the flooding is so brief that the water is often gone before the signs can be placed. Riverine flooding is not a direct threat to the village but does occur just outside the village limits. The Kokosing River is just south of State Route 229, which follows the southern border of Gambier. The Kokosing does breach its banks on occasion. There is significant open floodplain area along the river that generally contains this flooding. In the most serious incidents, floodwater can reach or cross State Route 229. This does not directly impact property in Gambier but does create a transportation challenge as residents must select other routes to travel in and out of town.

Tornadoes/wind storms and severe thunderstorms are the third and fourth most concerning incidents for the village. These varying types of wind event contribute to power outages by damaging trees and utility lines and creating hardship for residents. Gambier is a proud tree city and has lush vegetation throughout the village. While this creates a picturesque town and campus, it also creates the potential for significant debris and property damage in wind storms. Tornadoes in the village are rare but straight-line wind events are increasing in frequency. Severe thunderstorms are quite common but are not typically severe. In a widespread power outage, the village and Kenyon College would likely work together to provide shelter for residents and college students.

Winter storms are a concern primarily because of the potential for ice and a compromised power supply. As with wind events, the heavy tree coverage in the village increases the potential for power outages. Snowfall is not a significant concern but a temporary inconvenience.

Gambier officials rated drought/extreme heat and invasive species as moderate risks. Drought and extreme heat are rare. The greatest risk for Gambier is to the population, especially those with medical needs. Many of the buildings on Kenyon's campus are not air conditioned. In a prolonged heat event, the student population would have needs that are not present during normal temperatures. If the heat event were strong enough to impact the power supply, the impact would be even greater.

As a tree city, Gambier could be devastated by an invasive species that created a large quantity of dead or diseased trees. These weakened trees would also increase the likelihood of severe property damage during wind events and would increase flood risk by clogging ditches and streams and preventing floodwater from draining. While an invasive species infestation is not common, it could have a serious impact on the village if it did occur.

Hazardous materials incidents are a lower risk in Gambier than many neighboring jurisdictions. Because of the village's location on the hill, there is limited through traffic that moves through town. State Route 229 runs between the village and the Kokosing River; this is the route most likely to have commercial vehicles hauling hazardous substances. Kenyon College does have numerous science labs that utilize chemicals, some of which are hazardous. These are generally stored in small quantities and pose a relatively small risk.

Officials rated water quality as a minor risk because the village's supply is plentiful and the treatment plant is up to date. Land subsidence/landslide is a slightly higher risk in Gambier than in other areas of Knox County because of its higher elevation and location on a hill; the risk is still considered low by local officials. There are no structures known to be at risk and no evidence of sink holes or other similar issues. Earthquake was considered a very low risk.

2.3.6 Gann/Brinkhaven

Gann is the smallest jurisdiction in Knox County. Historically, the village was known as Brinkhaven although Gann is its current legal name. Located on the eastern edge of Knox County, Gann has more hills and elevation changes than the majority of Knox County and is along the banks of the Mohican River. While flooding does not occur frequently, officials ranked it as one of their top concerns because of the severity when it does happen. When the Mohican River overflows its banks, the water crosses State Route 62, which is the primary transportation route connecting the village to Mount Vernon and other communities. When the river reaches this level, it can take multiple days to recede. While the roads are covered, Gann residents must use narrow back roads to reach nearby cities for work and other needs, causing great inconvenience.

Infrastructure issues were ranked as the highest concern in Gann. As a very small jurisdiction with limited financial resources, the village has no public utilities. All residents utilize private wells and septic systems for water and wastewater; stormwater is managed through natural drainage. Road maintenance is performed by contractors hired by the village for snow removal and minor repairs. Gann has no direct employees. While water is considered plentiful, some residents have had water quality issues with their wells that have required drilling of new wells; this issue does not impact all residents but is widespread enough that planning team members discussed it at length during work sessions. Electrical outages have also been a concern because the village is small and tends to be a lower priority for service restoration than larger jurisdictions. The village works to maintain trees on the public right -of-way to reduce outages as much as possible; this work is performed by contractors hired by the village. Gann's village hall is the only public building and it does not have a backup generator. There are no dams or levees within the village.

Severe thunderstorms, wind, and tornadoes are the next most concerning incidents for the village. These incidents contribute to power outages by damaging trees and utility lines and creating hardship for residents. Residential structures are susceptible to wind damage. Storm shelter is a challenge in Gann because there are so few public buildings that are suitable to house people during an emergency. The village hall is very small and would not function well as a storm shelter. There is one church that may be available but residents would most likely travel to Danville, the nearest jurisdiction, for more appropriate storm shelter.

Winter storms are a concern because the village can become isolated from neighboring communities. There are no retail stores in Gann so residents travel to Mount Vernon or other nearby towns to purchase necessary supplies. In severe winter weather events, it can be difficult for residents to travel for work or supplies. The village also contract with a private service provide for snow removal services, which can sometimes delay the timeframe in which the village's roads are plowed and salted, further isolating residents.

Hazardous materials spills are a minor concern because of the substances that are carried on State Route 62. There are no facilities in the village that store or manufacture hazardous materials so the village's risk is primarily related to transport of substances. Drought was

considered a low risk because it is very infrequent. Residents receive water through private wells and the supply is considered more than adequate even in drought conditions. Invasive species is considered a minor risk because of the short- and long-term damage to trees and the increased risk for debris to clog waterways and damage structures and utility lines during flood and wind events.

Land subsidence/landslide and earthquake were considered minimal risks for the village.

2.3.7 Martinsburg

Martinsburg is Knox County's second smallest community. The village identified infrastructure failure as it's greatest concern. If any critical infrastructure systems were to fail, the safety of residents would be challenged. Utilities are provided by the village and private entities. Because the village is somewhat isolated from other communities, a long utility outage would be a challenge as residents must travel to neighboring communities for services. The local gas station and convenience store does have a generator so residents have access to fuel and some supplies. As a small village, the budget to maintain streets is limited. Wear and tear on the roads, however, is significant because of the amount of commercial and passenger traffic that crosses the village every day. Ongoing damage from water also damages roadways. There are no dams or levees within the village limits.

Flooding ranked as Martinsburg's second concern. Flash flooding is the most common problem and occurs during heavy precipitation events. It generally impacts streets and intersections. Some basements flood throughout the jurisdiction but it is extremely rare for first floor living spaces to be impacted. There are no waterways in the village so riverine flooding is not a primary concern.

Damage from wind events, including windstorms/tornadoes and severe thunderstorms, ranked as the third and fourth hazards for the village. Wind can impact the power supply, which causes great hardship for residents. Structures are also vulnerable to wind damage, as are trees and other vegetation. This type of damage is costly for the village and residents to clean up.

Winter storms were considered a moderate hazard primarily because of the potential impact from ice storm events. Ice storms often lead to many downed trees and power lines. As a small jurisdiction, Martinsburg is often a lower priority for power restoration than larger jurisdictions. This means that residents may be without necessary medical equipment, heating and cooling in their homes, and other critical services for several days following a major ice storm. While this does not occur frequently, it is a significant concern for village officials and residents.

Hazardous materials incidents are a concern because of the state highways that cross directly through Martinsburg. These routes bring significant commercial traffic through the village, including vehicles hauling diesel fuel and other hazardous substances. In the event of an accident or spill, much of the village would be directly affected.

Drought/extreme heat was ranked as a low risk because of it occurs very infrequently. When it does occur, the direct impact on property would be minimal. The potential impact on people, especially those with medical conditions and the elderly, could be significant. Invasive species is was also considered a minor risk. This hazard does not occur frequently but when it does, the long-term damage to trees and the increased risk for damage to utility lines and increased debris to clog storm sewers and drainage basins is significant.

Water quality is considered a low risk for the village. The groundwater supply in the region is plentiful and residents have not experienced water quality issues in the past. In spite of this history, officials recognize the potential for this type of incident and the serious impact it would have on residents should it occur.

The village ranked land subsidence/landslide and earthquake as minimal risks for the village.

2.3.8 Mount Vernon

As the county's most populated jurisdiction, Mount Vernon is the most developed community and the area most likely suffer loss of life and property damage in a major disaster. The planning team identified infrastructure failure as their primary concern. The city maintains water, wastewater, and stormwater utilities. They recently created a stormwater utility to fund necessary maintenance and upgrades to that system. Improving and maintaining these systems is a priority but the cost is an ongoing challenge. The same issue exists for transportation infrastructure in Mount Vernon. The city maintains and upgrades roads and bridges but the ongoing wear and tear from heavy traffic, precipitation, freezing and thawing, and other issues makes this difficult. Within the city limits, there is one class I dam. This dam is privately owned but there is some dispute over what entity is responsible for maintaining the structure and developing the emergency action plan. The dam is located in a residential community and is near numerous medical offices, businesses, and the hospital. Because of the population that falls within the dam's inundation zone, the city is concerned about maintaining the structure.

Flooding was determined to be the city's second highest rated hazard. Flash flooding is a more significant concern than riverine flooding. During heavy precipitation events, some streets will flood temporarily until the water can drain through the city's stormwater system. While this flooding does not last for long, it creates travel headaches in some locations and causes repetitive damage to city streets. Mount Vernon lies just south of the juncture of the North Branch Kokosing and the Kokosing Rivers. In heavy precipitation and snowmelt, the city can receive increased water flow through the central business district and some residential and industrial areas. While it does not happen often, there is some risk of riverine flooding and ice jams in this area.

Tornado/wind events, severe thunderstorms, and winter storms were rated as the next most concerning incidents for Mount Vernon. Residential and commercial structures are vulnerable to wind damage from tornadoes or straight-line winds. The city has numerous mobile home parks; these structures are more susceptible to wind damage than homes with traditional foundations. Utility lines and trees are easily damaged by heavy wind and can block roadways

and damage structures as they fall. In winter storms, ice is one of the biggest concerns. Ice storms often include power outages, which significantly increase the hardship on the community.

Because of the number of highways that traverse Mount Vernon, hazardous materials incidents are another significant concern. Hazardous substances are routinely transported through the city on state highways, many of which twist and turn through Mount Vernon. This creates an increased risk for a spill during transit. The city is also home to numerous industrial facilities that manufacture, store, or use hazardous substances in their process. While Knox County and Mount Vernon do not have many railroad lines, there are numerous gas transmission pipelines in the area.

Drought and extreme heat are moderate to low concerns for Mount Vernon. While this hazard can occur, it is quite rare. The city's water supply is plentiful so it would take an extreme drought event for consumption restrictions to be enacted. Extreme heat is a challenge for the city's elderly population and anyone with a medical condition, especially if the power supply is impacted.

Invasive species is a concern because of the potential impact on trees and vegetation. Any disease that impacts trees increases the debris potential during wind events. Dead and diseased trees can also fall into waterway and cause blockages, increasing the risk for flooding.

Water quality was rated as a fairly low risk for Mount Vernon. The city's water supply is plentiful and there are no known water quality issues in this region of Ohio. The city does closely monitor and test their public water supply, as required by EPA regulations, and works to maintain the water treatment plant to prevent water quality issues from occurring. The planning team members also identified land subsidence/landslide and earthquake as minimal risks for Mount Vernon. There are no known sinkhole or karst areas in the city nor is there any record of earthquakes occurring in the area.

2.3.9 Vulnerability Summary

The table below provides a summary of the hazard rank developed by each jurisdiction. Across the county, the hazards were ranked consistently from one jurisdiction to the next.

Table 2-36: Jurisdictional Vulnerability

Jurisdiction	Drought/ Extreme Heat	Earthquake	Flood	Hazardous Materials	Infrastructure Failure	Invasive Species	Land Subsidence/ Landslide	Severe Thunderstorm	Tornado/ Windstorm	Water Quality	Winter Storm
Knox County	7	11	2	6	1	8	10	4	3	9	5
Centerburg	7	11	2	6	1	8	10	4	3	9	5
Danville	7	11	2	6	1	8	10	4	3	9	5
Fredericktown	7	11	2	6	1	8	10	4	3	9	5
Gambier	7	11	2	6	1	8	10	4	3	9	5
Gann/Brinkhaven	7	11	2	6	1	8	10	4	3	9	5
Martinsburg	7	11	2	6	1	8	10	4	3	9	5
Mount Vernon	7	11	2	6	1	8	10	4	3	9	5

2.4 RISK ANALYSIS

To determine Knox County's overall risk, each hazard was evaluated and scored based on common criteria: frequency, response duration, speed of onset, magnitude, and impact on businesses, people, and property. This section describes the rating scale used by the planning team.

Frequency

Hazard events that occur regularly are a higher risk than those that occur infrequently.

- 1 = None/Once in 100 years
- 2 = Low/Once in 50 years
- 3 = Medium/Once in 25 years
- 4 = High/Once in 1-3 years
- 5 = Excessive/More than annual

Response Duration

Response duration is defined as the amount time the response to a particular hazard is anticipated to last.

- 1 = Less than ½ day
- 2 = Less than 1 day
- 3 = Less than 1 week
- 4 = Less than 1 month
- 5 = More than 1 month

Speed of Onset

Speed of onset addresses the amount of advance warning before each hazard occurs.

- 1 = More than 24 hours
- 2 = 12-24 hours
- 3 = 6-12 hours
- 4 = Less than 6 hours
- 5 = No warning

Magnitude

Magnitude was evaluated based on the percentage of the population that would be affected by an incident.

- 1 = < 10% of population affected directly
- 2 = 11-25% of population affected directly
- 3 = 26-50% of population affected directly
- 4 = > 50% of population affected directly

Business Impact

Business impact refers to the potential economic impact a hazard event is likely to have on a community. The definition of each score refers to the amount of time critical facilities are likely to be shut down in the impacted community.

- 1 = Less than 24 hours
- 2 = 1 week
- 3 = At least 2 weeks
- 4 = More than 30 days

Human Impact
Human impact is defined as the number of lives potentially lost for a particular hazard.

- 1 = Minimum/Minor injuries
- 2 = Low/Some injuries
- 3 = Medium/Multiple severe injuries
- 4 = High/Multiple fatalities

Property Impact
Property impact is defined as the number amount of property potentially lost during a given hazard event.

- 1 = Less than 10% damaged
- 2 = 10-25% damaged
- 3 = 25-50% damaged
- 4 = More than 50% damaged

These factors were assigned values as described and rated against anecdotal analysis based upon history and past incidents. This scoring mechanism resulted in very similar assessment of risks and vulnerabilities for the countywide vulnerability analysis. Table 2-37 provides the composite countywide risk analysis of these hazards.

Table 2-37: Risk Analysis

Hazard	Frequency	Response Duration	Speed of Onset	Magnitude	Business Impact	Human Impact	Property Impact	Score	Rank
Drought/Extreme Heat	2	1	1	1	1	1	1	8	7
Earthquake	1	2	4	1	1	1	1	11	11
Flood	5	3	3	3	2	2	2	20	2
Hazardous Materials	3	2	5	1	1	2	1	15	6
Infrastructure Failure	4	3	5	3	2	1	2	20	1
Invasive Species	2	1	1	1	1	1	1	8	8
Land Subsidence/Landslide	2	1	1	1	1	1	1	8	10
Severe Thunderstorm	5	1	3	2	1	1	1	14	4
Tornado/Windstorm	5	2	3	2	2	2	2	18	3
Water Quality	2	2	4	2	1	1	1	14	9
Winter Storm	4	1	2	3	1	2	1	14	5