BROWN COUNTY MULTI-HAZARD MITIGATION PLAN

DRAFT - DECEMBER 2022

Prepared for:

Brown County Emergency Management Agency
55 State Road 46 East
Nashville, IN 47448

Prepared by:

Christopher B. Burke Engineering, LLC
115 W. Washington St., Ste. 1368 S.
Indianapolis, IN 46204

Burke Project No. 19.R210348.00000

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF EXHIBITS

APPENDICES

EXECUTIVE SUMMARY

The Federal Emergency Management Agency (FEMA) defines the disaster life cycle as the process through which emergency managers respond to disasters when they occur; help people and institutions recover from them; reduce the risk of future losses; and prepare for emergencies and disasters. The Brown County Multi-Hazard Mitigation Plan (MHMP) focuses on the mitigation phase of the disaster life cycle. According to FEMA, mitigation is most effective when it's based on an inclusive, comprehensive, long-term plan that is developed before a disaster occurs. The MHMP planning process identifies hazards, the extent that they affect the municipality, and formulates mitigation practices to ultimately reduce the social, physical, and economic impact of the hazards.

For National Flood Insurance Program (NFIP) communities to be eligible for future mitigation funds, they must adopt either their own MHMP or participate in the development of a multi-jurisdictional MHMP. Further, it is required that local jurisdictions review, revise, and resubmit the MHMP every five years. As representatives from **Brown County and the Town of Nashville** have provided information, attended meetings, and participated in the planning process, the planning process used to update the Brown County MHMP satisfies the requirements of a multi-jurisdictional plan.

During Planning Committee meetings, those in attendance revisited existing (in the 2016 MHMP) and identified new critical facilities and local hazards; reviewed the State's mitigation goals and updated the local mitigation goals and updated the local mitigation goals; reviewed the most recent local hazard data, vulnerability assessment, and maps; evaluated the effectiveness of existing mitigation measures and identified new mitigation projects; and reviewed materials for public participation. Meetings were also conducted with key groups such as city planners and various emergency responders and their information will continue to be incorporated into the MHMP update.

Risk Assessment

The risk assessment conducted for the Brown County MHMP is based on the methodology described in the Local Multi-Hazard Mitigation Planning Guidance published by FEMA in 2013 and is incorporated into the following sections:

1. **Hazard Identification** lists the natural, technological, and political hazards selected as having the greatest direct and indirect impact to the county as well as the system used to rank and prioritize the hazards.
2. **Hazard Profile** for each hazard, discusses the 1) historic data relevant to the municipalities where available; 2) vulnerability in terms of number and type of structures, repetitive loss properties (flood only), estimation of potential losses, and impacts based on an analysis of development trends; and 3) the relationship to other hazards identified.
3. **Hazard Summary** provides an overview of the risk assessment process; a table summarizing the relationship of the hazards; and a composite map to illustrate areas impacted by hazards.

When considering the hazards selected for study (drought; earthquake; extreme temperature; fire; flood; hail, thunder, wind; land subsidence; snow and ice storm; tornado; dam failure; and hazardous materials incidents) and the information obtained regarding the hazard profile and the hazard summary, the attached table identifies the hazards studied and ranking outcome. The ranking is completed utilizing the Calculated Risk Priority Index (CPRI), a tool by which individual hazards are evaluated and ranked according to an indexing system considering probability, magnitude, warning time, and duration for any hazard.

1. **Probability** is defined as the likelihood of the hazard occurring over a given period.

2. **Magnitude/Severity** is defined by the extent of the injuries, shutdown of critical infrastructure, the extent of property damage sustained, and the duration of the incident response.
3. **Warning Time** is defined as the length of time before the event occurs.
4. **Duration** is defined as the length of time that the actual event occurs. This does not include response or recovery efforts.

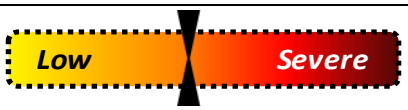
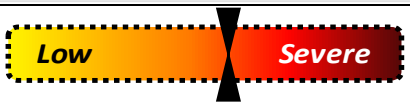
Mitigation Goals and Practices

The overall goal of the Brown County MHMP is to reduce the physical, economic and social losses associated with hazard incidents through emergency services, natural resource protection, prevention, property protection, public information, and structural control mitigation practices.

As part of the planning process the Planning Committee discussed the strengths and weaknesses of existing mitigation practices and made recommendations for improvements, as well as suggested new practices. To provide further detail, information on the local status, local priority, benefit-cost ratio, project location, responsible entity, and potential funding source are included regarding each proposed practice. Those practices ranked by participants as a high priority are anticipated to be implemented within five years from the final Plan adoption and additional steps, or an implementation plan is included for each.

Plan Maintenance

The successful implementation of the MHMP requires the participation and cooperation of the entire Planning Committee to successfully monitor, evaluate, and update the Brown County MHMP. Local jurisdictions are required to update and resubmit the MHMP every five years. Information gathered following individual hazard incidents and annual meetings will be utilized along with updated vulnerability assessments to assess the risks associated with each hazard common in Brown County.

Type of Hazard	List of Hazards	Weighted Average CPRI
Natural	Drought	
	Earthquake	
	Extreme Temperatures	
	Wildfire	
	Flood – Flash and Riverine	
	Hail/Thunder/Windstorm	
	Landslide/Subsidence	
	Tornado	
	Winter Storm/Ice	
Technological	Dam Failure	
	Hazardous Materials Incident	

CHAPTER 1: INTRODUCTION

1.1 DISASTER LIFE CYCLE

The Federal Emergency Management Agency (FEMA) defines the disaster life cycle as the process through which emergency managers respond to disasters when they occur; help people and institutions recover from them; reduce the risk of future losses; and prepare for emergencies and disasters. The disaster life cycle, shown in **Figure 1,** includes four phases:

Figure 1: Disaster Life Cycle

- **Response** – the mobilization of the necessary emergency services and first responders to the disaster area (search and rescue; emergency relief)
- **Recovery** – to restore the affected area to its previous state (rebuilding destroyed property, re-employment, and the repair of other essential infrastructure)
- **Mitigation** – to prevent or to reduce the effects of disasters (building codes and zoning, vulnerability analyses, public education)
- **Preparedness** – planning, organizing, training, equipping, exercising, evaluation and improvement activities to ensure effective coordination and the enhancement of capabilities (preparedness plans, emergency exercises/training, warning systems)

The Brown County Multi-Hazard Mitigation Plan (MHMP) focuses on the mitigation phase of the disaster life cycle. According to FEMA, mitigation is most effective when it's based on an inclusive, comprehensive, long-term plan that is developed before a disaster occurs. Recent reviews of grant programs have determined for every $1 spent on mitigation efforts, between $6 and $10 are saved within the community on efforts following disasters. The MHMP planning process identifies hazards, the extent that they affect the municipality, and formulates mitigation practices to ultimately reduce the social, physical, and economic impact of the hazards.

1.2 PROJECT SCOPE & PURPOSE

REQUIREMENT §201.6(d)(3):
A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for approval within five (5) years in order to continue to be eligible for mitigation project grant funding.

An MHMP is a requirement of the Federal Disaster Mitigation Act of 2000 (DMA 2000). According to DMA 2000, the purpose of mitigation planning is for State, local, and Indian tribal governments to identify the natural hazards that impact them, to identify actions and activities to reduce any losses from those hazards, and to establish a coordinated process to implement the plan, taking advantage of a wide range of occurrences.

A FEMA-approved MHMP is required to apply for and/or receive project grants under the Building Resilient Infrastructure and Communities (BRIC), Hazard Mitigation Grant Program (HMGP), and Flood Mitigation Assistance (FMA). Although the Brown County MHMP meets the requirements of DMA 2000 and eligibility requirements of these grant programs, additional detailed studies may need to be completed prior to applying for these grants.

For National Flood Insurance Program (NFIP) communities to be eligible for future mitigation funds, they must adopt either their own MHMP or participate in the development of a multi-jurisdictional MHMP. The Indiana Department of Homeland Security (IDHS) and the United States Department of Homeland Security (US DHS)/FEMA Region V offices administer the MHMP program in Indiana. As noted above, it is required that local jurisdictions review, revise, and resubmit the MHMP every five years. MHMP updates must demonstrate that progress has been made in the last five years to fulfill the commitments outlined in the previously approved MHMP. The updated MHMP may validate the information in the previously approved Plan or may be a major plan rewrite. The updated MHMP is not intended to be an annex to the previously approved Plan; it stands on its own as a complete and current MHMP.

The Brown County MHMP Update is a multi-jurisdictional planning effort led by the Brown County EMA. This Plan was prepared in partnership with Brown County and the town of Nashville. Representatives from these communities attended the Committee meetings, provided valuable information about their community, reviewed and commented on the draft MHMP, and assisted with local adoption of the approved Plan. As each of the jurisdictions had an equal opportunity for participation and representation in the planning process, the process used to update the Brown County MHMP satisfies the requirements of DMA 2000 in which multi-jurisdictional plans may be accepted.

Throughout this Plan, activities that could count toward Community Rating System (CRS) points are identified with the NFIP/CRS logo. The CRS is a voluntary incentive program that recognizes and encourages community floodplain activities that exceed the minimum NFIP requirements. As a result, flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions that meet the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote education and awareness of flood insurance. Savings in flood insurance premiums are proportional to the points assigned to various activities. A minimum of 500 points is necessary to enter the CRS program and receive a 5% flood insurance premium discount. This MHMP could contribute as many as 382 points toward participation in the CRS. At the time of this planning effort, none of the communities or the county participate in the CRS program.

Funding to update the MHMP was made available through a FEMA/DHS grant awarded to the Brown County EMA and administered by IDHS. Brown County provided the local 25% match required by the grant. Christopher B. Burke Engineering, LLC (Burke) was hired to facilitate the planning process and prepare the Brown County MHMP under the direction of an American Institute of Certified Planners (AICP) certified planner.

1.3 ANALYSIS PROCESS

REQUIREMENT §201.6(c)(1):
The plan shall document the planning process used to prepare the plan, including how it was prepared, who was involved in the process, and how the public was involved.

Preparation for the Brown County MHMP Update began in 2020, the grant request was approved by FEMA and grant funds were awarded in 2021.

Once the grant was awarded, the planning process to update the 2016 MHMP took 18 months. This included a review period by IDHS and FEMA for the draft MHMP Update, and time for Brown County and communities to adopt the final MHMP Update.

1.3.1 Planning Committee

In July of 2021, the EMA compiled a list of Planning Committee members to guide the MHMP update planning process. These individuals were specifically invited to serve on the Committee because they were knowledgeable of local hazards; have been involved in hazard mitigation; have the tools necessary to reduce the impact of future hazard events; and/or served as a representative on the original Planning Committee in 2016. **Table 1** lists the individuals that actively participated on the Committee and the entity they represented.

Table 1: MHMP Update Committee

Name	Office	Representing
Seleah Settle	Brown County Health Department Nursing Supervisor	Brown County
Jennifer Heller	Brown County Health Department Environmental Health Specialist	Brown County
Arlan Peirce	Hamblen Township Volunteer Fire Department	Brown County
Christopher Henderson	IU Health Lifeline – EMAC Chair	Brown County
Corey Frost	Brown County Health Department Emergency Preparedness	Brown County
David Frensemeier	IU Health Lifeline & Hamblen Township Volunteer Fire Dept.	Brown County
Mike Magner	Brown County Highway Department	Brown County
Helen Caves	Health Services Lead south Indiana Red Cross	Red Cross
Sandie Jones	Town of Nashville	Nashville
Susan Armstrong	Brown County Emergency Management	Brown County

Members of the Committee participated in the MHMP Update as a Planning Committee member or through various other group meetings. During these meetings, the Committee:

- Revisited existing (in the 2016 MHMP) and identified new critical infrastructure and local hazards
- Reviewed the State's mitigation goals and updated the local mitigation goals
- Reviewed the most recent local hazard data, vulnerability assessment, and maps
- Evaluated the effectiveness of existing mitigation measures and identified new mitigation projects
- Reviewed materials for public participation.

Sign-in sheets recorded those present at each meeting to document participation. Meeting agendas and summaries are included in **Appendix 2**. Members of the Committee also reviewed a draft MHMP, provided comments and suggestions, and assisted with adoption of the Brown County MHMP Update.

1.3.2 Public Involvement

A draft of the Brown County MHMP Update was posted to the Brown County website for public review and comment. A media release indicating the posting of the draft MHMP and the ability to comment was submitted for publishing to *The Brown County Democrat* and social media sites for the EMA. Committee members were provided with an informational flyer regarding the same information to display in their respective offices and to provide to family, friends and colleagues. ___ comments or corrections were received from the public or the Committee. The media release, informational flyer, and any comments received are included in **Appendix 3**.

1.3.3 Involvement of Other Interested Parties

Neighboring EMAs (Bartholomew, Jackson, Johnson, and Monroe Counties) were also invited to review and comment on the MHMP update. Information related to the planning process and the availability of the draft Brown County MHMP was directly provided to representatives via personal conversations, informational flyer, and email correspondence. Successful implementation and future updates of the Brown County MHMP Update will rely on the partnership and coordination of efforts between such groups. No comments or corrections were received from the neighboring EMA offices.

1.4 PLANS, STUDIES, REPORTS, AND TECHNICAL INFORMATION

During the development of the Brown County MHMP Update, several relevant sources of information were reviewed either as a document or through discussions with local personnel. This exercise was completed to gather updated information since the development of the previous Brown County MHMP, and to assist the Committee in developing potential mitigation measures to reduce the social, physical, and economic losses associated with hazards affecting Brown County.

For the purposes of this planning effort, the following materials (among others) were discussed and utilized:

- Brown County Zoning Ordinance, 2022
- Brown County MHMP, 2016

REQUIREMENT §201.6(c)(1):
The plan shall include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

- Brown County Comprehensive Plan, 2011
- Brown County Floodplain Ordinance, 2016
- Brown County GIS data

The Brown County Building Department provides services for the unincorporated portions of Brown County. The Town of Nashville Development Review Commission regulates construction within the Town of Nashville.

In addition to local agencies and offices such as those listed above, several regional and state agencies were contacted and subsequently provided data for this planning effort. Those contacts, and the information they provided, include:

- Indiana Department of Natural Resources, Division of Water – *Flood insurance policies, claims, and payment information*
- Indiana Department of Natural Resources, Division of Water – *Dam records*
- FEMA, Region V – Repetitive loss structure counts and payments

The CRS program credits NFIP communities a maximum of 155 points for organizing a planning committee composed of staff from various departments; involving the public in the planning process; and coordinating among other agencies and departments to resolve common problems relating to flooding and other known natural hazards.

CHAPTER 2: COMMUNITY INFORMATION

Although much of the information within this section is not required by DMA 2000, this section contains important background information about the physical, social, and economical composition of Brown County necessary to better understand the Risk Assessment discussed in **Chapter 3**.

On February 4, 1836, Brown County was formed from western Bartholomew, eastern Monroe, and northern Jackson counties. It was named for Gen. Jacob Brown, who defeated the British at the Battle of Sackett's Harbor in the War of 1812. Brown County was a rugged county for many years with villages remaining the centers of Brown County life into the early 1900's. The county covers 320 square miles, measuring 16 miles from east to west and 20 miles from north to south. The rugged hilly terrain and heavily forested areas (90% coverage) attract artists and outdoor recreators alike. According to the Comprehensive Plan for Brown County, a major portion of the acreage in Brown County continues to be non-taxable contributing to the difficulty of the financing of local government. A few examples of the nontaxable land include but limited to, National and State Forest, State Park, Church Camps, Land trust, Charitable owned, and others. The Cordry and Sweetwater Lake areas are the most heavily populated. Tourism continues as the primary business and numerous art and craft studios are scattered throughout the county, their products being sold locally and throughout the country. Visitors are curious about the rural lifestyle, the history of the local people, and the artists and continue to be drawn to scenic Brown County year-round. The location of the county within the State of Indiana is identified in **Figure 2**.

2.1 POPULATION AND DEMOGRAPHICS

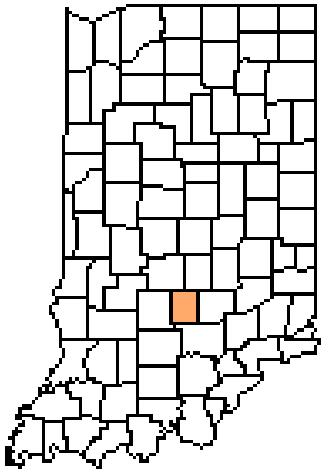


Figure 2: Brown County Location

The US Census Bureau estimates that the 2021 population for Brown County was 15,552, which ranks 79th in the State. Of that total, the Town of Nashville accounts for 1,266 or 8.1% of the county's population.

In 2021, the median age of the population in the county was 50.5 years of age. The largest demographic age groups in the county are older adults (45-64) with a population of 4,837 and Seniors (65 and older) with a population of 4,005. are the third largest age group young adults (25-44 years) with a population of 3,109 individuals living in Brown County. The approximate median household income in 2019 was reported to be $59,617 while the poverty rate in the same year was reported at 10.5% county-wide. In total, 16.9% of households are married with children, and 49.2% of households are married without children.

Within the county, 93.4% of the adults older than 25, have reportedly completed a High School education. Further, 29.3% of those same adults have also completed a Bachelor of Arts or higher degree.

2.2 EMPLOYMENT

US Census data indicate that of the Brown County workforce, 16.9% are employed in private businesses not otherwise classified. Government and retail trade account for 14.1% and 11.0% respectively. The total resident labor force according to estimates in 2021 is 7,637 (with 248 unemployed) and a May 2022 unemployment rate of 2.4% which places Brown County as 33rd of 92 counties in the State. **Table 2** lists the ten largest employers within Brown County as of 2020.

Table 2: List of Major Employers

Brown County Health and Living – Nursing Home	Jehovah's Witnesses - Church
Brown County High School	Abe Martin Lodge
Brown County State Park	Brown County Inn
Salt Creek Golf Retreat	Brown County IGA
Nashville Elementary School	Story Inn, Seventeen West Main Inc., Seasons Lodge, and Artist's Colony

2.3 TRANSPORTATION AND COMMUTING PATTERNS

Figure 3: Brown County Transportation Routes

Several major transportation routes pass through Brown County and the municipalities within. State Roads 45, 46, 67, and 135 serve as main routes between the various municipalities. The Indiana Railroad Company travels through the northwestern portion of the county from the Morgan and Johnson County lines north of Fruitdale to Monroe County and Bloomington exiting Brown County near Lake Lemon. These transportation routes are identified in **Figure 3**.

According to STATSIndiana, nearly 828 people commute into Brown County daily. Approximately 42% of commuters travel from Monroe and Bartholomew Counties. Further, approximately 3,799 Brown County residents commute to other counties, with 1/3 commuting to Bartholomew County and the remainder to Marion, Johnson and Monroe Counties.

Figure indicates the number of workers 16 and older who do not live within Brown County but commute into the County for employment purposes.

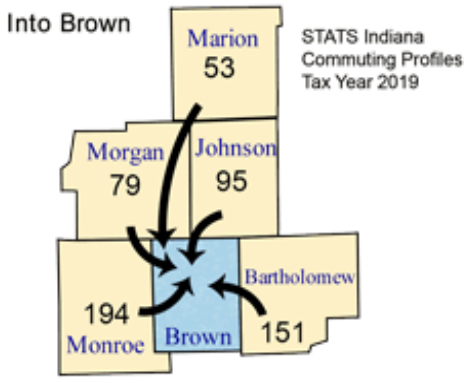


Figure 4: Commuting into Brown County

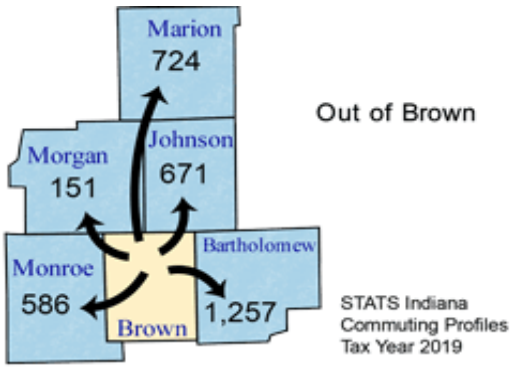


Figure 5: Commuting out of Brown County

Similarly, **Figure** indicates the number of Brown County residents 16 and older that commute out of the county for employment.

2.4 CRITICAL AND NON-CRITICAL INFRASTRUCTURE

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

Critical facilities, or critical infrastructure, are the assets, systems, and networks, whether physical or virtual, so vital to the local governments and the United States that their incapacitation or destruction would have a debilitating effect on security, economic security, public health or safety, or any combination thereof.

These structures are vital to the community's ability to provide essential services and protect life and property; are critical to the community's response and recovery activities; and/or are the facilities, the loss of which, would have a severe economic or catastrophic impact. The operation of these facilities becomes especially important following a hazard event.

The Brown County EMA and County Surveyor's Office provided the listing and locations of the following 200 critical infrastructure points for the MHMP update:

- Airports
- Churches
- Communication Facilities
- Community Gathering Places
- 133 Dams
- Daycares
- 1 Emergency Management Agency
- Energy
- 7 Fire/EMS Stations
- 2 Government Facilities
- 26 Large Employers
- 3 Medical Facilities
- Mobile Home Communities
- 1 Nursing Home
- 1 Police Stations
- 2 Red Cross Shelters
- 6 Schools
- 8 Tier II Facilities
- 7 Water Towers
- 3 Wastewater Treatment Plants
- Water Treatment Plants

Information provided by the EMA, County Surveyor's Office, and the MHMP Planning Committee members was utilized to identify the types and locations of critical structures throughout Brown County. Draft maps were provided to the Planning Department and EMA, along with the Planning Committee for their review and all comments were incorporated into the maps and associated databases.

Exhibit 1 illustrates the critical infrastructure identified throughout unincorporated Brown County and the individual municipalities. **Appendix 4** lists the critical structures in Brown County by community. Non-critical structures include residential, industrial, commercial, and other structures not meeting the definition of a critical facility and are not required for a community to function. The development of this MHMP focused only on critical structures; non-critical structures are neither mapped nor listed.

2.5 MAJOR WATERWAYS AND WATERSHEDS

According to the United States Geological Survey (USGS), there are 74 waterways in Brown County, which are listed in **Appendix 5**. The county's main waterways are the Bear, Bean Blossom, Clay Lick, East Fork Salt, Gnaw Bone, Gravel, Lick, Middle Fork Salt, North Fork Salt, South Fork Salt, and Sweetwater Creeks. The county lies within multiple 8-digit Hydrologic Unit Code (HUC): Driftwood, Lower East Fork White, Upper East Fork White, Lower White, and Upper White. These major waterways, and others, are identified on **Exhibit 2**.

2.6 NFIP PARTICIPATION

The NFIP is a FEMA program that enables property owners in participating communities to purchase insurance protection against losses from flooding. Brown County and the town of Nashville, participate in the NFIP. At the time of this planning effort, according to the Indiana Department of Natural Resources, the Brown County Planning Commission Director is responsible for the administration of the floodplain program in the unincorporated areas of the County. As well as the Town of Nashville.

Table 3 lists the NFIP number, effective map date, and the date each community joined the NFIP program.

Table 3: NFIP Participation

NFIP Community	NFIP Number	Effective Map Date	Join Date
Brown County	185174A	12/08/2016	04/13/1973
Town of Nashville	180018A	12/08/2016	01/24/1976

2.7 TOPOGRAPHY

Brown County is bordered geographically to the west by Monroe County, to the east by Bartholomew County, to the north by Johnson and Morgan Counties, and to the south by Jackson County. The third highest elevation in the state is located at Weed Patch Hill at 1,058 feet. The county is described to be in the Norman Upland physiographic region. The Knobstone Escarpment, a part of the Norman Upland, is a ridgeline that runs from Brown County all the way to southern Indiana. The Knobstone Escarpment is characterized by the undulating steep-sided hills and valleys made of primarily siltstone rich in silica. The Norman Upland features deeply entrenched valleys of the Bean Blossom and Salt Creeks and their tributaries. 90% of the landmass in Brown County is forested earning the county the most Forested County in Indiana moniker.

2.8 CLIMATE

The Midwestern Regional Climate Center (MRCC) provided climate data that includes information retrieved from a weather station located Columbus Indiana, identified as station USC00121747. The average annual precipitation is 44.21 inches per year, with the wettest month being May averaging 5.27 inches of precipitation and the driest month being February with an average of 2.64 inches of precipitation. The highest 1-day maximum precipitation was recorded in July of 1998 with 6.37 inches of rain. On average, there are 77.4 days of precipitation greater than or equal to 0.1 inch; 30.6 days with greater than or equal to 0.5 inch; and 11 days with greater than or equal to 1.0 inch of precipitation.

Annual Average Temperature range from a minimum of 43.3 degrees to a maximum of 63.7 degrees. The coldest month based on 1981 – 2010 NCEI normals for this station is January at a mean temperature of 29 degrees and the warmest is July with a mean temperature of 75.7degrees. On February 21, 2018, a one-day maximum temperature of 79 degrees was recorded during the winter season.

Studies have recently been completed by the Indiana Climate Change Impacts Assessment, which is overseen by Purdue University Climate Change Research Center and comprised of a Steering Committee and several topic-oriented Working Groups. These studies indicate that average annual precipitation for Indiana is increasing seasonally during the winter and spring. Conversely, summers and autumns are trending toward less precipitation. In addition, their report shows changes in rain intensity and duration, along with frost-free days and growing seasons. These changes in climate, especially in Indiana, will impact natural hazards and how municipalities prepare for them.

CHAPTER 3: RISK ASSESSMENT

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

A risk assessment measures the potential loss from a hazard incident by assessing the vulnerability of buildings, infrastructure, and people in a community. It identifies the characteristics and potential consequences of hazards, how much of the community may be affected by a hazard, and the impact on community assets. The risk assessment conducted for Brown County and the communities within is based on the methodology described in the Local Multi-Hazard Mitigation Planning Guidance published by FEMA in 2011 and is incorporated into the following sections:

Section 3.1: Hazard Identification lists the natural, technological, and political hazards selected by the Planning Committee as having the greatest direct and indirect impact to the county as well as the system used to rank and prioritize the hazards.

Section 3.2: Hazard Profile for each hazard, discusses 1) historic data relevant to the county where applicable; 2) vulnerability in terms of number and types of structures, repetitive loss properties (flood only), estimation of potential losses, and impact based on an analysis of development trends; and 3) the relationship to other hazards identified by the Planning Committee.

Section 3.3: Hazard Summary provides an overview of the risk assessment process; a table summarizing the relationship of the hazards; and a composite map to illustrate areas impacted by the hazards.

3.1 HAZARD IDENTIFICATION

3.1.1 Hazard Selection

The MHMP Planning Committee reviewed the list of natural and technological hazards from the 2016 Brown County MHMP and discussed recent events and the potential for future hazard events. The Committee identified those hazards that affected Brown County and each community and selected the hazards to study in detail as part of this planning effort. As shown in **Table 4**, these hazards include dam failure; drought; earthquake; extreme temperature; wildfire; flooding; hailstorms, thunderstorms, and windstorms; hazardous materials incident; land subsidence/landslides; snowstorms and ice storms; cyber-attack and tornado. All hazards studied within the 2016 Brown County MHMP are included in the update.

Table 4: Hazard Identification

Type of Hazard	List of Hazards	Detailed Study	
		2016 MHMP	MHMP UPDATE
Natural	Drought	Yes	Yes
	Earthquake	Yes	Yes
	Extreme Temperature	Yes	Yes
	Wildfire/Fire	Yes	Yes
	Flood	Yes	Yes
	Hail/Thunder/Wind	Yes	Yes
	Land Subsidence/Landslide	Yes	Yes
	Snow / Ice Storm	Yes	Yes
	Tornado	Yes	Yes
Technological	Dam Failure	Yes	Yes
	Hazardous Material Incident	Yes	Yes

3.1.2 Hazard Ranking

The Planning Committee ranked the selected hazards in terms of importance and potential for disruption to the community using a modified version of the Calculated Priority Risk Index (CPRI). The CPRI, adapted from MitigationPlan.com, is a tool by which individual hazards are evaluated and ranked according to an indexing system. The CPRI value (as modified by Burke) can be obtained by assigning varying degrees of risk probability, magnitude/severity, warning time, and the duration of the incident for each event, and then calculating as index value based on a weighted scheme. For ease of communications, simple graphical scales are used.

Probability

Probability is defined as the likelihood of the hazard occurring over a given period. The probability can be specified in one of the following categories:

- Unlikely – incident is possible, but not probable, within the next 10 years
- Possible – incident is probable within the next five years
- Likely - incident is probable within the next three years
- Highly Likely – incident is probable within the next calendar year

Magnitude / Severity

Magnitude/severity is defined by the extent of the injuries, shutdown of critical infrastructure, the extent of property damage sustained, and the duration of the incident response. The magnitude can be specified in one of the following categories:

- Negligible – few injuries OR critical infrastructure shutdown for 24 hours or less OR less than 10% property damaged OR average response duration of less than six hours
- Limited – few injuries OR critical infrastructure shut down for more than one week OR more than 10% property damaged OR average response duration of less than one day
- Significant – multiple injuries OR critical infrastructure shut down of at least two weeks OR more than 25% property damaged OR average response duration of less than one week
- Critical – multiple deaths OR critical infrastructure shut down of one month or more OR more than 50% property damaged OR average response duration of less than one month

Warning Time

Warning time is defined as the length of time before the event occurs and can be specified in one of the following categories:

- More than 24 hours
- 12-24 hours
- 6-12 hours
- Less than six hours

Duration

Duration is defined as the length of time that the actual event occurs. This does not include response or recovery efforts. The duration of the event can be specified in one of the following categories:

- Less than six hours
- Less than one day
- Less than one week
- Greater than one week

Calculating the CPRI

The following calculation illustrates how the index values are weighted and how the CPRI value is calculated. CPRI = Probability x 0.45 + Magnitude/Severity x 0.30 + Warning Time x 0.15 + Duration x 0.10. For the purposes of this planning effort, the calculated risk is defined as:

- **Low** if the CPRI value is between 1 and 2
- **Elevated** if the CPRI value is between 2 and 3
- **Severe** if the CPRI value is between 3 and 4

The CPRI value provides a means to assess the impact of one hazard relative to other hazards within the community. A CPRI value for each hazard was determined for each incorporated community in Brown County, and then a weighted CPRI value was computed based on the population size of each community. **Table 5** presents each community, population, and the weight applied to individual CPRI values to arrive at a combined value for the entire county. Weight was calculated based on the average percentage of each community's population in relation to the total population of the county. Thus, the results reflect the relative population influence of each community on the overall priority rank.

Table 5: Determination of Weighted Value for Communities

Community	Population (2020)	% of Total Population	Weighted Value
Brown County	14,457	93%	0..93
Town of Nashville	1,095	7%	0.07
Total	**15,552**	**100.0%**	**1.00**

3.2 HAZARD PROFILES

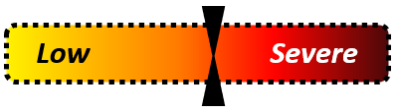
The hazards studied for this report are not equally threatening to all communities throughout Brown County. While it would be difficult to predict the probability of an earthquake or tornado affecting a specific community, it is much easier to predict where the most damage would occur in a known hazard area such as a floodplain or near a facility utilizing an Extremely Hazardous Substance (EHS). The magnitude and severity of the same hazard may cause varying levels of damages in different communities.

This section describes each of the hazards that were identified by the Planning Committee for detailed study as a part of this MHMP Update. The discussion is divided into the following subsections:

- **Hazard Overview** provides a general overview of the causes, effects, and characteristics that the hazard represents

- **Historic Data** presents the research gathered from local and national courses on the hazard extent and lists historic occurrences and probability of future incident occurrence
- **Assessing Vulnerability** describes, in general terms, the current exposure, or risk, to the community regarding potential losses to critical infrastructure and the implications to future land use decisions and anticipated development trends
- **Relationship to Other Hazards** explores the influence one hazard may have upon another hazard.

3.2.1 Drought



Overview

Drought, in general, means a moisture deficit extensive enough to have social, environmental, or economic effects. Drought is not a rare and random climate incident; rather, it is a normal, naturally recurring feature of climate. Drought may occur in virtually all climactic zones, but its characteristics vary significantly from one region to another. Drought is a temporary aberration and is different from aridity, which is restricted to low rainfall regions.

Figure 4: Urban Drought Effects

There are four academic approaches to examining droughts; these are meteorological, hydrological, agricultural, and socio-economic. Meteorological drought is based on the degree, or measure, of dryness compared to a normal, or average amount of dryness, and the duration of the dry period. Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply. Agricultural drought is related to agricultural impacts; and focuses on precipitation shortages, differences between actual and potential evapo-transpiration, soil water deficits, reduced ground water or reservoir levels, and crop yields. Socioeconomic drought relates the lack of moisture to community functions in the full range of societal functions, including power generation, the local economy, and food source **Figure 4** shows urban grassed areas affected by drought conditions.

Category	Description	Possible Impacts
D0	Abnormally Dry	Going into drought: ▪ short-term dryness slowing planting, growth of crops or pastures Coming out of drought: ▪ some lingering water deficits ▪ pastures or crops not fully recovered
D1	Moderate Drought	▪ Some damage to crops, pastures ▪ Streams, reservoirs, or wells low, some water shortages developing or imminent ▪ Voluntary water-use restrictions requested
D2	Severe Drought	▪ Crop or pasture losses likely ▪ Water shortages common ▪ Water restrictions imposed
D3	Extreme Drought	▪ Major crop/pasture losses ▪ Widespread water shortages or restrictions
D4	Exceptional Drought	▪ Exceptional and widespread crop/pasture losses ▪ Shortages of water in reservoirs, streams, and wells creating water emergencies

Figure 5: US Drought Monitor Severity Classification

Recent Occurrences

Data gathered from the U.S. Drought Monitor indicated that between June 1, 2015, and February 28, 2022, there were 43 weeks where some portions of Brown County was considered to be in "Abnormally Dry" or D0. According to the Drought Monitor, there were only 15 weeks within that period where any portion of Brown County was in a drought state higher than a D0. Between August - December 2016; August – November 2019 and September and November 2020 portions of the county reached D1 or "Moderate Drought". During this phase, damages to crops and pastures are beginning, streams and reservoirs begin to lower and water use restrictions may be suggested. **Figure 5**, from the U.S. Drought Monitor, describes the rationale to classify the severity of droughts.

The National Climate Data Center (NCDC) does not report any events or property or crop losses within Brown County during this planning period. During discussions with the Planning Committee, effects from the 2020 drought were highlighted. Dry conditions resulted in some large field/wildland fires. Both were contained and no crops were damaged.

The Planning Committee, utilizing the CPRI, determined the overall risk of drought throughout Brown County is "Elevated". The impact of drought was determined to be the same for all communities and unincorporated area throughout the county due to the possible agricultural impacts and impacts to water wells. The committee agreed that a drought is "Possible" (to occur within the next three years), and the magnitude of drought is anticipated to be "Limited" to "Significant." Further it is anticipated that with the enhanced weather forecasting abilities, the warning time for a drought is greater than 24 hours and the duration will be greater than one week. A summary is shown in **Table 6**.

Table 6: CPRI for Drought

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Brown County	**Possible**	**Significant**	**> 24 hours**	**> 1 week**	**Elevated**
Town of Nashville	**Possible**	**Limited**	**> 24 hours**	**> 1 week**	**Elevated**

According to the National Drought Mitigation Center, scientists have difficulty predicting droughts more than one month in advance due to the numerous variables such as precipitation, temperature, soil moisture, topography, and air-sea interactions. Further anomalies may also enter the equation and create more dramatic droughts or lessen the severity of droughts. Based on the previous occurrences of significant droughts and drought related impacts felt within Brown County, the Committee estimated that the probability of a drought occurring in the area is "Possible"; or occurrence is probable within the next three years.

"Limited" to "Significant" damages are anticipated throughout the county as the municipalities rely on groundwater supplies for fire response efforts and face a higher risk during times of prolonged drought. Throughout the unincorporated areas of the county, increased crop, and livestock damages would also be expected during a significant drought. In addition, the long-term stress on the forested land could result in additional tree deaths and debris during subsequent high wind events.

Assessing Vulnerability

This type of hazard will generally affect entire counties and even multi-county regions at one time. Within Brown County, direct and indirect effects from a long period of drought may include:

Direct Effects:

- Urban and developed areas may experience revenue losses from decreased tourism, landscaping companies, golf courses, restrictions on industry cooling and processing demands, businesses dependent on crop yields, and increased potential for fires
- Rural areas within the county may experience revenue losses from reductions in decreased tourist activities, livestock and crop yields as well as increased field fires
- Citizens served by drinking water wells or surface water supplies may be impacted during low water periods and may require drilling of deeper wells or loss of water service for a period of time

Indirect Effects:

- Loss of income of employees from businesses and industry affected; loss of revenue to support services (food service, suppliers, etc.)
- Loss of revenue from recreational or tourism sectors associated with reservoirs, streams, and other open water venues
- Lower yields from domestic gardens increasing the demand on purchasing produce and increased domestic water usage for landscaping
- Increased demand on emergency responders and firefighting resources

Estimating Potential Losses

Figure 6: Crops Affected by Drought

It is difficult to estimate the potential losses associated with a drought for Brown County because of the nature and complexity of this hazard and the limited data on past occurrences. However, for the purpose of this MHMP update, a scenario was used to estimate the potential crop loss and associated revenue lost due to a drought similar to that experienced during the drought of record from 1988. In 2021, Brown County produced approximately 322,000 bushels of corn and 123,000 bushels of soybeans, as reported by the United States Department of Agriculture (USDA) National Agricultural Statistics Service. Using national averages of $5.45 per bushel of corn and $13.10 per bushel of soybeans, the estimated crop receipts for 2021 would be $3.37M. Using the range of crop yield decreases reported in 1988 and 1989, just after the 1988 drought period (50%-86%) and assuming a typical year, economic losses could range between $1.68M-$2.89M; depending on the crop produced and the market demand. Effects of drought on corn crops can be seen in **Figure 6**.

Purdue Agriculture News reports that as of March 2013, Indiana producers received more than $1.0B in crop insurance payments for 2012 corn, soybean, and wheat losses. This amount is nearly double that of the previous record, $522M following 2008 losses, also due to drought. These losses are still considered to be record-setting in terms of drought effects, damages, and costs for Indiana.

According to a July 5, 2012, article in The Times (Noblesville, IN), "The effects of drought also could touch agricultural businesses, such as handlers and processors, equipment dealers, and see, fertilizer and pesticide providers." Additional losses associated with a prolonged drought are more difficult to quantify. Drought has lasting impacts on urban trees: death to all or portions of a tree, reduction in the tree's ability to withstand insects and diseases, and interruption of normal growth patterns. Such effects on trees, especially urban trees can lead to additional impacts, both environmentally and monetarily in terms of the spread of Emerald Ash Borer insect and the weakening of tree limbs and trunks which may lead to increased damages during other hazard events such as wind and ice storms.

Future Considerations

Advancements in plant hybrids and development have eased the impacts from short-lived droughts. Seeds and plants may be more tolerant of drier seasons and therefore fewer crop losses may be experienced.

As the municipal areas of the county continue to grow and expand, protocols may need to be developed which create a consistency throughout the communities and the unincorporated portions of the county for burn bans and water usage advisories.

According to the Indiana Climate Change Impacts Assessment, Indiana has experienced a rise in the average annual precipitation between 1895 and 2016; an increase of 6.9 inches for the area of Brown County (climate division #8). This increase in precipitation may lessen the likelihood or overall impact of a drought in Brown County. However, the assessment also notes seasonal shifts in precipitation which may lead to seasonal short-term droughts. In either scenario, changes in precipitation are not anticipated to relieve the area of a probability of a drought occurring.

Prior to municipalities expanding, provisions and considerations should be given regarding the potential additional demand for both water usage and fire response efforts. Following such expansion or development plans, alternative water sources should be explored. Since the previous MHMP was prepared, large scale and significant development has not occurred throughout the county. The majority of Brown County remains largely unincorporated and rural in nature.

Relationship to Other Hazards

Discussions with the Planning Committee were held regarding the similar effects of prolonged periods of extreme heat and the similar impacts that may be experienced during these times. Planning and mitigation efforts for one hazard may benefit the other. It is anticipated that rural areas of the county may be more susceptible to brush and rangeland or woodland fires during a drought, while urban areas may experience these impacts in areas where several abandoned buildings or overgrown lots exist, and this may lead to increased losses associated with a fire.

3.2.2 Earthquake

Overview

An earthquake is a sudden, rapid shaking of the earth caused by the breaking and shifting of rock beneath the earth's surface. For hundreds of millions of years, the forces of plate tectonics have shaped the earth as the huge plates that form the earth's surface move slowly over, under, and past each other. Sometimes the movement is gradual. At other times, the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free, causing the ground to shake. Most earthquakes occur at the boundaries where the plates meet; however, some earthquakes occur in the middle of the plates.

Ground shaking from earthquakes can collapse buildings and bridges; disrupt gas, electric, and phone service; and sometimes trigger landslides, avalanches, flash floods, fires, and huge destructive ocean waves (tsunamis). Buildings with foundations resting on unconsolidated landfill and other unstable soil, and trailers and homes not tied to their foundations are at risk because they can move off their mountings during an earthquake. When an earthquake occurs in a populated area, it may cause deaths, injuries, and extensive property damage.

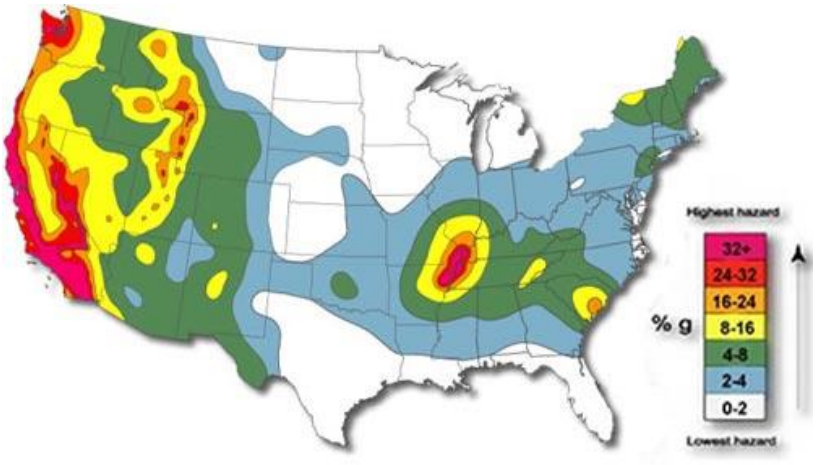


Figure 7: Earthquake Hazard Areas in the US

Earthquakes strike suddenly, without warning. Earthquakes can occur at any time of the year and at any time of the day or night. On a yearly basis, 70-75 damaging earthquakes occur throughout the world. Estimates of losses from a future earthquake in the United States approach $200B.

One method of measuring the magnitude or energy of an earthquake is the Richter Scale. This scale uses whole numbers and decimal fractions whereby each increase of a whole number represents a release of 31 times more energy than the amount associated with the previous whole number on the scale. Scientists are currently studying the New Madrid fault area and have predicted that the chances of an earthquake in the M8.0 range occurring within the next 50 years are approximately 7%-10%. However, the chances of an earthquake at a M6.0 or greater, are at 90% within the next 50 years.

There are 45 states and territories in the United States at moderate to very high risk from an earthquake, and they are located in every region of the county (**Figure 7**). California experiences the most frequent damaging earthquakes; however, Alaska experiences the greatest number of large earthquakes – most located in uninhabited areas. The largest earthquakes felt in the United States were along the New Madrid Fault in Missouri, where a three-month long series of quakes from 1811 to 1812 occurred over the entire Eastern United States, with Missouri, Tennessee, Kentucky, Indiana, Illinois, Ohio, Alabama, Arkansas, and Mississippi experiencing the strongest ground shaking.

Recent Occurrences

Indiana, as well as several other Midwestern states, lies in the most seismically active region east of the Rocky Mountains. Regarding Brown County, the nearest areas of concern are the Wabash Seismic Zone and the New Madrid Fault Zone.

On June 17, 2021, an earthquake centered near Bloomingdale, Indiana in Parke County was felt as far north as Chicago, Illinois and as far east as Cincinnati, Ohio. With a magnitude of 3.8 several localized reports included descriptions of shaking buildings and feelings of tremors. No injuries or severe damages were reported due to this incident. As reported by the NBC 5 Chicago, "Once the earthquake was confirmed, officials said the 9-1-1 phone line "started ringing immediately."" Before this event, the last earthquake to be felt in Indiana was a magnitude 5.1 centered in Sparta, North Carolina and the last event to actually occur within the state was a magnitude 2.3 earthquake centered in Haubstadt, IN on May 28, 2015. No injuries or damages were reported with either of these events.

On December 30, 2010, central Indiana experienced an earthquake with a magnitude of 3.8; rare for this area in Indiana as it is only the 3rd earthquake of notable size to occur north of Indianapolis. Even rarer is the fact that scientists believe that the quake was centered in Greentown, Indiana approximately 13 miles southeast of Kokomo, Indiana. According to The Kokomo Tribune, "113 people called 911 in a 15-minute period after the quake, which was the first tremblor centered in Indiana since 2004". Further, a geophysicist from the USGS in Colorado stated, "It was considered a minor earthquake", and "Maybe some things would be knocked off shelves, but as far as some significant damage, you probably wouldn't expect it from a 3.8".

Figure 8: Earthquake Damaged Porch

A M5.8 centered in Mineral, Virginia affected much of the East Coast on August 23, 2011. According to USA Today, 10 nuclear power plants were shutdown of precautionary inspections following the quake, over 400 flights were delayed, and the Washington Monument was closed indefinitely pending detailed inspections by engineers.

Based on historical earthquake data, local knowledge of previous earthquakes, results of HAZUS-MH scenarios, and that Brown County has not been directly impacted by an earthquake, the Committee determined that the probability of an earthquake occurring in Brown County or any of the communities is "Possible". Should an earthquake occur, the impacts associated with this hazard are anticipated to be "Significant" within the Town of Nashville, but "Limited" in all other areas of the county. As with all earthquakes, it was determined that the residents of Brown County would have little to no warning time (less than six hours) and that the duration of the event would be expected to also be less than one week. A summary is shown in **Table 7**.

Table 7: CPRI for Earthquake

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Brown County	**Possible**	**Limited**	**< 6 hours**	**< 1 week**	**Elevated**
Town of Nashville	**Possible**	**Significant**	**< 6 hours**	**< 1 week**	**Elevated**

Per the Ohio Department of Natural Resources Division of Geological Survey, "…it is difficult to predict the maximum-size earthquake that could occur in the state and certainly impossible to predict when such an event would occur. In part, the size of an earthquake is a function of the area of a fault available for rupture. However, because all known earthquake-generating faults in Ohio are concealed beneath several thousand feet of Paleozoic sedimentary rock, it is difficult to directly determine the size of these faults." Further according to the Indiana Geological Survey, "…no one can say with any certainty when or if an earthquake strong enough to cause significant property damage, injury, or loss of life in Indiana will occur…we do indeed face the possibility of experiencing the potentially devastating effects of a major earthquake at some point in the future". The Committee felt that an earthquake occurring within or near to Brown County is "Possible" to occur within the next five years.

Figure 9: Minor Earthquake Damages

Assessing Vulnerability

Earthquakes generally affect broad areas and potentially many counties at one time. Within Brown County, direct and indirect effects from an earthquake may include:

Direct Effects:

- Urban areas may experience more damages due to the number of structures, the multi-story nature of the structures and critical infrastructure located in these areas
- Rural areas may experience losses associated with agricultural structures such as barns and silos
- Bridges, buried utilities, and other infrastructure may be affected throughout the county and municipalities

Indirect Effects:

- Provide emergency response personnel to assist in the areas with more damage
- Provide shelter for residents of areas with more damage
- Delays in delivery of goods or services originating from areas more affected by the earthquake

Types of loss caused by an earthquake could be physical, economic, or social in nature. Due to the unpredictability and broad impact regions associated with an earthquake, all critical and non-critical infrastructure are at risk of experiencing earthquake related damages. Damages to structures, infrastructure, and even business interruptions can be expected following an earthquake. Examples of varying degrees of damages are shown in **Figure 8** and **Figure 9**.

Estimating Potential Losses

In order to determine the losses associated with an earthquake, the HAZUS-MH software was utilized in the Brown County MHMP update to determine the potential impacts anticipated from an arbitrary earthquake scenario. This scenario placed a magnitude 5.0 within Brown County located in downtown Nashville at the intersections of SR 135 and SR46. This type of modeling is useful for planning efforts such as this.

Per the HAZUS-MH scenario noted above, total economic losses are anticipated to be near $259.3M with moderate damages to approximately 981 buildings, of which 61 are anticipated to be damaged beyond repair. Further, there are 12 critical facilities with reduced functionality on day 1, and 1 highway segment with moderate damage. All other transportation segments (railways, buses, etc.) would be expected to remain undamaged. The utilities are anticipated to have at least two wastewater facilities with moderate damages. Approximately 40,000 tons of debris would need to be removed from the area requiring 1,400 dump trucks. Forty-one households are expected to be displaced following the event with twenty-two residents seeking assistance with shelter.

The HAZUS-MH model computes anticipated economic losses for the hypothetical earthquake due to direct building losses and business interruption losses. Direct building losses are the costs to repair or to replace the damage caused to the building and contents, while the interruption losses are associated with the inability to operate a business due to the damage sustained. Business interruption losses also include the temporary living expenses for those people displaced from their homes.

The HAZUS-MH Earthquake Model allows local building data to be imported into the analysis. However, these local data are imported as "general building stock", meaning that the points are assigned to a census tract rather than a specific XY coordinate. HAZUS performs the damage analysis as a county wide analysis and reports losses by census tract. While the results of the hypothetical scenario appear to be plausible, care should be taken when interpreting these results.

Future Considerations

While the occurrence of an earthquake in or near to Brown County may not be the highest priority hazard studied for the development of the plan, it is possible that residents, business owners, and visitors may be affected should an earthquake occur anywhere within the state. For that reason, Brown County should continue to provide education and outreach regarding earthquakes and even earthquake insurance along with education and outreach for other hazards. As Brown County and the communities within the county grow and develop, the proper considerations for the potential of an earthquake to occur may help to mitigate against social, physical, or economic losses in the future.

It can be anticipated that while all structures in Brown County will remain at-risk to earthquake damages and effects, new construction or redevelopment may reduce the overall risks. As redevelopment or growth occurs, the new construction may be significantly sturdier. Further, as blighted or abandoned areas are addressed, those communities and the county as a whole, are less susceptible to economic and physical damages associated with earthquakes. Since the last planning effort, no significant development has occurred within the county.

Relationship to Other Hazards

Hazardous materials incidents may occur as a result of damage to material storage containers or transportation vehicles involved in road crashes or train derailments. Further, dam failures or landslides may occur following an earthquake or associated aftershocks due to the shifting of the soils in these hazard areas. These types of related hazards may have greater impacts on Brown County communities than the earthquake itself. It is not expected that earthquakes will be caused by other hazards studied within this plan.

3.2.3 Extreme Temperature

Overview

Extreme Heat

Extreme heat is defined as a temporary elevation of average daily temperatures that hover 10 degrees or more above the average high temperature for the region for the duration of several weeks. Humid or muggy conditions, which add to the discomfort of high temperatures, occur when a dome of high atmospheric pressure traps water-laden air near the ground. In a normal year, approximately 175 Americans die from extreme heat.

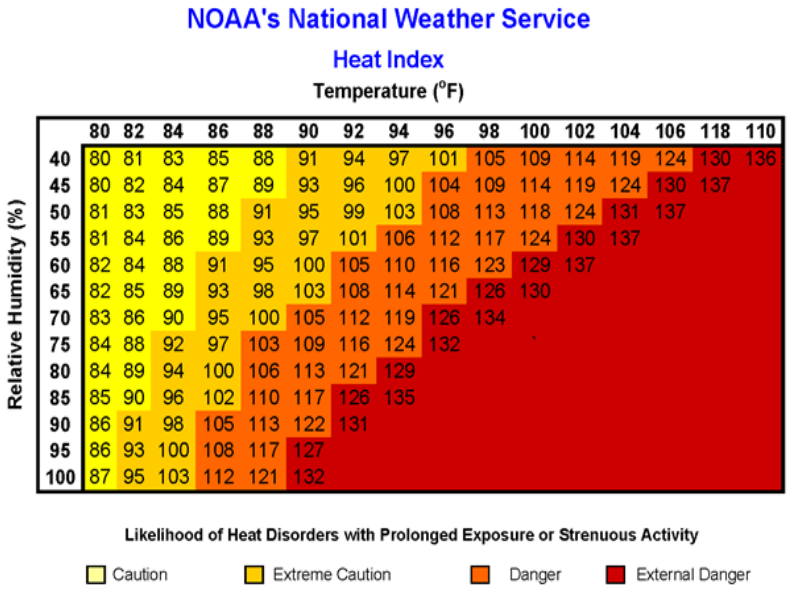


Figure 10: Heat Index Chart

According to the NWS, "The Heat Index or the "Apparent Temperature" is an accurate measure of how hot it really feels when the Relative Humidity is added to the actual air temperature". To find the Heat Index Temperature, refer to the Heat Index Chart in **Figure 10**. As an example, if the air temperature is 96°F and the relative humidity is 65%, the heat index – how hot it feels – is 121°F. The Weather Service will initiate alert procedures when the Heat Index is expected to exceed 105°-110°F for at least two consecutive days.

It is important to also note that these heat index values were devised for shady, light wind conditions. Exposure to full sunshine may increase heat index values by up to 15°F. Further, strong winds, particularly with very hot, dry air, can also be extremely hazardous.

As **Figure 11** indicates, there are four cautionary categories associated with varying heat index temperatures. Each category provides a heat index range along with effects on the human body. People with underlying health issues, the very old or very young may be impacted at lower temperatures since their systems are less likely to be able to compensate for the heat and humidity.

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

Figure 11: Heat Index Categories

Extreme Cold

Figure 12: Frozen Brown County Landscape, Our Brown County Magazine Jan/Feb 2019

Extreme cold is defined as a temporary, yet sustained, period of extremely low temperatures. Extremely low temperatures can occur in winter months when continental surface temperatures are at their lowest point and the North American Jet Stream pulls arctic air down into the continental United States. The jet stream is a current of fast-moving air found in the upper levels of the atmosphere. This rapid current is typically thousands of kilometers long, a few hundred kilometers wide, and only a few kilometers thick. Jet streams are usually found somewhere between 10-15 km (6-9 miles) above the Earth's surface. The position of this upper-level jet stream denotes the location of the strongest surface temperature contrast over the continent. The jet stream winds are strongest during the winter months when continental temperature extremes are greatest. When the jet stream pulls arctic cold air masses over portions of the United States, temperatures can drop below 0° F for one week or more. Sustained extreme cold poses a physical danger to all individuals in a community and can affect infrastructure function as well.

In addition to strictly cold temperatures, the wind chill temperature must also be considered when planning for extreme temperatures. The wind chill temperature, according to the NWS, is how cold people and animals feel when outside and it is based on the rate of heat loss from exposed skin. **Figure 13** identifies the Wind Chill Chart and how the same ambient temperature may feel vastly different in varying wind speeds.

Wind chill is a guide to winter danger

New wind chill chart

Frostbite occurs in 15 minutes or less

Wind (MPH) \ Temperature (°F)	30	25	20	15	10	5	0	-5	-10	-15	-10	-25
5	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40
10	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47
15	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51
20	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55
25	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58
30	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60
35	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62
40	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64
45	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65
50	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67
55	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68
60	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69

Figure 13: NWS Wind Chill Chart

Recent Occurrences

The effects of extreme temperatures extend across large regions, typically affecting several counties, or states, during a single event. According to the NCDC, there have been no extreme heat event or extreme cold events between June 2016 and June 2022. Local reports did not provide any additional information regarding a period of excessive heat during this time period. However, Indianapolis National Weather Service reported wind chills of -31 in Bloomington just west of Brown County and

-30 in Columbus just east of Brown County on January 30 and 31, 2019. No additional reports were provided relevant to damages or losses associated with the prolonged cold temperatures.

It is difficult to predict the probability that an extreme temperature event will affect Brown County residents within any given year. However, based on historic knowledge and information provided by the community representatives, an extreme temperature event is "Possible" (event is possible within the next 5 years) to occur and if an event did occur, it would result in "Limited" to "Significant" magnitude. **Table 8** identifies the CPRI for extreme temperatures-both heat and cold events for all communities in Brown County and the Town of Nashville.

Table 8: CPRI for Extreme Temperatures

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Brown County	**Possible**	**Limited**	**> 24 hours**	**> 1 week**	Elevated
Town of Nashville	**Possible**	**Significant**	**> 24 hours**	**> 1 week**	Elevated

As shown in the table, index values are increased within the Town of Nashville due to the centralized population and location of critical infrastructure potentially impacted by the extreme temperatures. The anticipation of experiencing "Limited" damages within the unincorporated area is due to the number of livestock operations and acres of cropland and the more prepared and self-reliant population located in the rural areas.

Assessing Vulnerability

As noted above, this type of hazard will generally affect entire counties and even multi-county regions at one time; however, certain portions of the population may be more vulnerable to extreme temperatures. For example, outdoor laborers, very young and very old populations, low-income populations, and those in poor physical condition are at an increased risk to be impacted during these conditions.

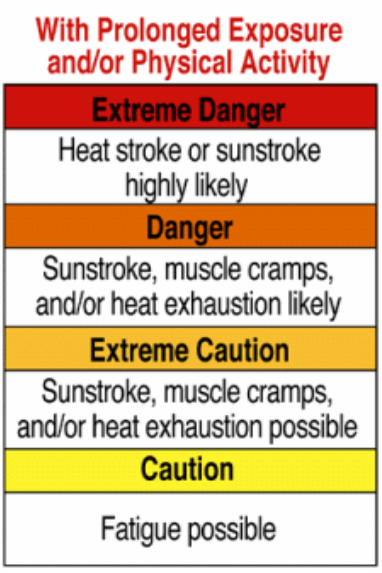


Figure 14: Danger Levels with Prolonged Heat Exposure

By assessing the demographics of Brown County, a better understanding of the relative risk that extreme temperatures may pose to certain populations can be gained. In total, just over 24.3% of the county's population is over 65 years of age, 6% of the population is below the age of 5, and approximately 9.9% of the population is considered to be living below the poverty line. People within these demographic categories are more susceptible to social or health related impacts associated with extreme heat.

Extreme heat can affect the proper function of organ and brain systems by elevating core body temperatures above normal levels. Elevated core body temperatures, usually in excess of 104°F are often exhibited as heat stroke. For weaker individuals, an overheated core body temperature places additional stress on the body, and without proper hydration, the normal mechanisms for dealing with heat, such as sweating in order to cool down, are ineffective. Examples of danger levels associated with prolonged heat exposure are identified in **Figure 14**.

Extreme cold may result in similar situations as body functions are impacted as the temperature of the body is reduced. Prolonged exposure to cold may result in hypothermia, frostbite, and even death if the body is not warmed.

Within Brown County, direct and indirect effects from a long period of extreme temperature may include:

Direct Effects:

- Direct effects are primarily associated with health risks to the elderly, infants, people with chronic medical disorders, lower income families, outdoor workers, and athletes

Indirect Effects:

- Increased need for cooling or warming shelters
- Increased medical emergency response efforts
- Increased energy demands for heating or cooling

Estimating Potential Losses

It is difficult to estimate the potential losses due to extreme temperatures as damages are not typically associated with buildings but instead, with populations and persons.

This hazard is not typically as damaging to structures or critical infrastructure as it is to populations so monetary damages associated with the direct effects of the extreme temperature are not possible to estimate accurately. Indirect effects would cause increased expenses to facilities such as healthcare or emergency services, manufacturing facilities where temperatures are normally elevated may need to alter work hours or experience loss of revenue if forced to limit production during the heat of the day, and energy suppliers may experience demand peaks during the hottest and/or coldest portions of the day. With extreme cold indirect effects include pipes freezing resulting in loss of access to water for industrial processes as well as personal hygiene, sanitation and hydration of livestock and people.

Future Considerations

As more and more citizens are experiencing economic difficulties, local power suppliers along with charitable organizations have implemented programs to provide cooling and heating mechanisms to residents in need. Often, these programs are donation driven and the need for such assistance must be demonstrated. As susceptible populations increase, or as local economies are stressed, such programs may become more necessary to protect Brown County's at-risk populations.

The Climate Change Assessment identifies several temperature related considerations of which communities should be aware and begin planning to avoid further impacts. For example, rising temperatures will increase the number of extreme heat days, thereby increasing the potential for heat related illnesses, potential hospitalizations, and medication costs to vulnerable populations. In addition, added days of extreme heat will impact agriculture, manufacturing, and potentially, water sources.

New construction associated with development of residential areas often brings upgraded and more efficient utilities such as central heating and air units further reducing vulnerabilities to the aging populations in those municipalities mentioned above. Conversely, new development associated with industrial or large commercial structures in the inner-urban centers often result in increased heat over time, which may cause additional stress to labor-related populations. Since the last planning effort, there has not been significant residential and commercial development within the county.

Extreme Temperatures: Relationship to Other Hazards

While extreme temperatures may be extremely burdensome on the power supplies in Brown County, the Committee concluded that this type of hazard is not expected to cause any hazards studied. It is anticipated that due to prolonged extreme temperatures, primarily long periods of high temperatures, citizens may become increasingly agitated and irritable, and this may lead to a disturbance requiring emergency responder intervention.

3.2.4 Fire

Overview

Figure 15: Wildfire in Forested Area

A wildfire, also known as a forest fire, vegetation fire, or a bushfire, is an uncontrolled fire in wildland areas and is often caused by lightning; other common causes are human carelessness and arson. Small wildfires may be contained to areas less than one acre, whereas larger wildfires can extend to areas that cover several hundred or even thousand acres. Generally, ambient weather conditions determine the nature and severity of a wildfire event. Very low moisture and windy conditions can help to exacerbate combustion in forested or brush areas (**Figure 15**) and turn a small brush fire into a major regional fire event in a very short period. Wildfires can be very devastating for residents and property owners.

A structural fire is an incident where a fire starts within a structure and is largely contained to that structure. Causes of structure fires can be related to electrical shorts, carelessness with ignition sources, poor storage of flammable materials, as well as arson. These types of fires can be deadly if no warning or prevention measures are present. The most dangerous aspect of structural fires is the production of toxic gases and fumes that can quickly accumulate in enclosed areas of structures and asphyxiate those who might be in the structure.

Problems associated with structural fires are compounded when high-rise buildings catch fire. High-rise fires hinder the ability of rescue workers to fight the fire, reach impacted building occupants, and evacuate impacted occupants. Rescue efforts also become more complicated when handicapped or disabled persons are involved. Complications associated with high-rise fires typically increase as the height and occupancy levels of the buildings increase. Structural collapse is another concern associated with high-rise fires. Structural collapse often results in persons becoming trapped and severely injured. However, it is important to note that the concern associated with structural collapse, is not limited to high-rise buildings; the collapse of smaller residential buildings can also lead to severe injury and death.

Typically, a wildfire will incinerate all structures and objects in its path. A resident may lose all possessions and structures to a wildfire event. Additionally, combating a wildfire or a structure fire may be extremely dangerous. If weather conditions change suddenly, the wildfire may change course and overtake firefighters, causing severe injury or death. Fires can travel at speeds greater than 45 mph. Therefore, these hazard events can pose a serious threat to county residents and response agencies.

Recent Occurrences

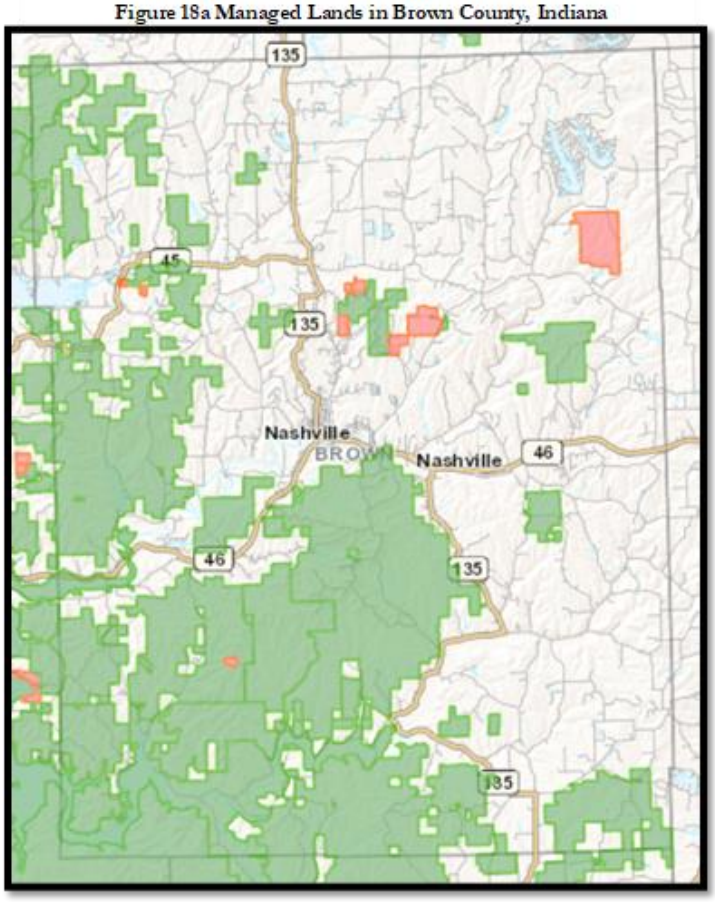
Within the NCDC, there are no reports of wildfires occurring within Brown County between January 1950 and February 2022. Within the same time parameter, there were only two reported events within the State of Indiana, both within Pike County and both within 2006. During each of these events over 350 acres were burned.

The NCDC does not report structure fires; therefore, local sources were utilized to provide information regarding residential and business fires. These fires are the typical hazard affecting Brown County in the last several years. A couple fires of note are the Carmel Corn Cottage fire in Nashville and the Gypsy Moth Flea Market Fire as can be seen in **Figure 16.**

Figure 16: Gypsy Moth Flea Market Fire *Photo credit Jack E Harden.*

Discussions took place regarding the vulnerability of the Town of Nashville the increased risk since many buildings have little space between structures. Thankfully, there has not been an event of a larger nature occurring in Nashville to date. The last business fire in town was at the Carmel Corn Cottage in 2022 and it was limited to the single business.

Figure 18a Managed Lands in Brown County, Indiana



With over 90% of the county landmass being forested, there are several areas (~54%) managed as a State Park, State Forest, or other managed area that may increase the risk for a forest fire affecting large areas of the county. **Figure 18a** identifies those areas (in green) relevant to Brown County. In April 2022, a 40acre plus wildland fire took place. On the same day a total of 9 wildland fires were fought by the local volunteer fire departments.

Due to the expansive acreage woods within Brown County, and the potential for urban areas to be at risk due to abandoned homes, blighted areas, or industrial activities, the Planning Committee determined the probability to be "Possible" throughout the County. **Table 9** identifies the CPRI rankings for fire in Brown County.

Table 9: CPRI for Fire

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Brown County	**Possible**	**Significant**	**< 6 hours**	**< 1 day**	Elevated
Town of Nashville	**Possible**	**Significant**	**< 6 hours**	**< 1 day**	Elevated

Information provided in **Table 10** highlights the number of fire runs for some of the Brown County fire departments for the time period beginning January 2018 through December 2021. Based on this information, annual damages to structures, contents, and vehicles may be significant for each municipality on an annual basis. Social losses, such as being unable to work following a residential structure fire or losses associated with a business fire should also be considered as an impact.

Table 10: Brown County Fire Runs

	2018	2019	2020	2021
CSW Fire Department	26	36	26	28
Fruitdale Fire Department	46	55	71	71
Hamblen Township Fire Department	57	71	77	65
Jackson Fire Department	43	50	58	62
Nashville Fire Department	117	118	121	131
Southern Brown Fire Department	20	26	35	44
Totals	**309**	**356**	**388**	**401**

Assessing Vulnerability

A fire typically affects a large regional area with potential for physical, economic, and/or social losses. Typically, a structural fire affects one or two structures, as one of the main functions of fire response is to prevent the fire from spreading to neighboring structures. This type of action works to reduce the magnitude and severity from "Limited" throughout the county and municipalities.

Much of the county is rural and forested, which may be more susceptible to brush or crop fires, especially in times of drought. Vulnerabilities to this hazard have not shifted in location. Municipal areas within Brown County are susceptible to urban and industrial fires, while the remainder of Brown County remains vulnerable to field, crop, and woodland fires.

Direct and indirect effects of a such an event within Brown County may include:

Direct Effects:

- Loss of structures
- Loss of forests
- Loss of natural resources and wildlife

Indirect Effects:

- Loss of revenue as businesses may be closed
- Loss of revenue from reduced tourist activities in the county
- Increased emergency response times based on safety of roads

- Loss of income if dependent on crop production or timber harvest

Estimating Potential Losses

Given the nature and complexity of a potentially large hazard such as a wildfire, it is difficult to quantify potential losses to property and infrastructure. As a result, all critical and non-critical structures and infrastructure may be at some degree of risk.

Monetary damages associated with the direct effects of the fires are difficult to estimate, other than utilizing historic information as provided. Indirect effects would cause increased efforts associated with emergency response services as wildfires are difficult to contain and may accelerate very quickly. Further, multi-level business or residential structures place increased risks to those who work or live within those structures or nearby structures.

Future Considerations

As populations increase and community growth increases, the need to respond to fire will remain an important municipal effort. As new construction or re-development occurs, especially new or existing critical infrastructure, it is important to ensure that these new structures are equipped to deal with the potential risks associated with this hazard. Those may include increased risk for wooden or flammable outer structures and potential lengthy power outages. With the adverse impacts of extreme temperatures and drought upon the heavily forested areas, consideration must be given to mitigating fire risks for structures that are built in the rural areas to limit losses should a wildland fire take place.

In addition, increased populations require increased housing. Many urban communities develop large multi-family residential structures, or apartment complexes, where structures are not only in close proximity to each other, but also contain a large number of citizens. As communities age, some structures may become abandoned, significantly increasing the risk of fire due to potential vagrant populations and lack of maintenance. These areas should be considered at-risk and potentially demolished to avoid such risk and potential hazard.

In areas such as Brown County which are reliant on volunteer firefighters, firefighting responses can be slowed due to the limited numbers of volunteers available at various times of the day. Increasing numbers of people working outside of the community in which they reside limits volunteer presence to outside of normal working hours. Recruitment initiatives will need to be considered as the firefighting needs and staffing levels change.

Fires can also result in substantial indirect costs. Increased emergency response times, loss of work or the inability to get to work, as well as business interruption, are possible indirect effects of a fire and how it may affect those businesses directly related to cropland or natural resource areas.

Relationship to Other Hazards

Fires may certainly result in a hazardous materials incident if storage structures are within the path of the burn. Material storage containers farther away from the burn path may become damaged by high winds and embers resulting in a spill or release of materials. Fires may result from lightning associated with a thunderstorm. Typical wind speeds during a thunderstorm may also exacerbate the impacts from any ignitions from the lightning.

3.2.5 Flood

Overview

Floods are the most common and widespread of all the natural disasters. Most communities in the United States have experienced some kind of flooding, after spring rains, heavy thunderstorms, or winter snow melts. A flood, as defined by the NFIP, is a general and temporary condition of partial or complete inundation or two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters and unusual and rapid accumulation or runoff of surface waters from any sources, or a mudflow. Floods can be slow or fast rising but generally develop over a period of days.

Flooding and associated flood damages is most likely to occur during the spring because of heavy rains combined with melting snow. However, provided the right saturated conditions, intense rainfall of short duration during summer rainstorms can produce damaging flash flood conditions.

The traditional benchmark for riverine or coastal flooding is a 1% Annual Exceedance Probability (AEP), or the 100-year flood. This is a benchmark used by FEMA to establish a standard of flood protection in communities throughout the country. The 1% AEP is referred to as the "regulatory" or "base" flood. Another term commonly used, the "100-year flood", can be misleading. It does not mean that only one flood of that size will occur every 100 years, but rather there is a 1% chance of a flood of that intensity and elevation happening in any given year. In other words, the regulatory flood elevation has a 1% chance of being equaled, or exceeded, in any given year and it could occur more than once in a relatively short time period. Yet another term for the area impacted by the 1% AEP flood event is the Special Flood Hazard Area (SFHA).

Recent Occurrences

The NCDC indicates that between June 1, 2015 and February 28, 2022, there was one flood and six flash floods reported. For these events, a total of $221K in property damages and an additional $2.0K in crop damages were reported. No reports of injuries or deaths have been provided regarding these events.

Figure 17: Flood Damaged Vehicles in Brown County, Indiana 2/8/2019

NCDC stated that several bridges were damaged due to the flash flooding countywide on June 19, 2021. Just two (2) years prior, on June 16, 2019, numerous roads were closed, especially south and west of Nashville including parts of State Road 46. Several water rescues were needed to remove people from rains swollen roadways and small streams. In Nashville some residents had to be rescued following the heavy rain event. This resulted in combined damages of $80,000. **Figure 17** shows the results of the flooding at one home in Brown County.

Stream gages are utilized to monitor surface water elevations and/or discharges at key locations and time periods. Some such gages are further equipped with NWS' Advanced Hydrologic Prediction

Service (AHPS) capabilities. These gages have the potential to provide valuable information regarding historical high and low water stages, hydrographs representing current and forecasted stages, and a map of the surrounding areas likely to be flooded. Within Brown County, there are one active USGS stream gages, at The North Fork Salt Creek at Nashville. Since 2015 the gage has not exceeded major flood stage of 21 feet. However, the gage has recorded river levels above moderate flood stage at 17 feet nine (9) times and above flood stage or 14 feet an additional fourteen (14) times.

Any property having received two insurance claim payments for flood damages totaling at least $1,000, paid by the NFIP within any 10-year period since 1978 is defined as a repetitive loss property. These properties are important to the NFIP because they account for approximately 1/3 of the country's flood insurance payments. According to FEMA Region V, there are a total of fifteen (15) repetitive loss structures within the unincorporated areas of Brown County, twelve (12) single family residences and 3 non-residential structures. An additional two structures (2 single-family residences) were identified in Nashville.

There have been several claims made for damages associated with flooding in Brown County since 1978. Within the unincorporated areas of the county, there have been 149 claims resulting in slightly over $3.07M in payments. Further, within the Town of Nashville, there were 31 payments totaling approximately $1.76. **Table 11** identifies the number of claims per community as well as payments made, as provided by IDNR.

Table 11: Repetitive Properties, Claims, and Payments

Community	# of Repetitive Loss Properties	Claims Since 1978	$$ Paid
Brown County	15	89	$1.1M
Town of Nashville	2	8	$2.1M
TOTAL	**17**	**97**	**$3.2M**

Mandatory flood insurance purchase requirements apply to structures in 1% AEP delineated areas. Total flood insurance premiums for Brown County and the communities are approximately $103.4K. Total flood insurance coverage for Brown County and the communities is slightly over $20.4M. **Table 12** further indicates the premiums and coverage totals for individual communities.

Table 12: Insurance Premiums and Coverage

Community	Flood Insurance Premiums	Flood Insurance Coverage
Brown County	$66.6K	$16.4M
Town of Nashville	$36.8K	$4.0M
TOTAL	**$103.4K**	**$20.4M**

As determined by the Committee, the probability of riverine based flooding occurring throughout Brown County ranges from "Likely" to "Highly Likely". This is largely based on the presence absence of rivers and streams near the communities. The Committee also determined that the warning time would be less than 6 hours based on the terrain and flashy nature of the waterways in the county, forecasting methods, and local knowledge of stream activities. Finally, the duration of such an event is anticipated to last less than one day for all areas.

The Planning Committee felt it necessary to separately discuss flash flooding and the impacts typical for each municipality. Many attendees felt flash flooding is more prominent throughout Brown County and brings a different set of considerations when completing the risk index as well as developing a set

of potential mitigation measures as will be completed later in the plan. The greatest difference is the duration associated with flash flooding is anticipated to be less than one day instead of less than one week as with the riverine flooding. **Table 13** provides the summary for flash flooding.

Table 13: CPRI for Flood – Flash and Riverine

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Brown County	**Highly Likely**	**Limited**	**< 6 hours**	**< 1 day**	**Severe**
Town of Nashville	**Likely**	**Limited**	**< 6 hours**	**< 1 day**	**Severe**

As mentioned within this section, there is a 1% chance each year that the regulatory flood elevation will be equaled or exceeded, and these types of events may occur more than once throughout each year. Further, based on information provided by the NCDC, and previous experiences, the Committee determined that flooding is "Likely" to "Highly Likely" throughout the county for both riverine and flash flooding.

Assessing Vulnerability

Flood events may affect large portions of Brown County at one time as river systems and areas with poor drainage cover much of the county and several communities. Due to terrain, poor drainage systems, and increased high volume rain events, the predominantly gravel roads within the county are vulnerable to the erosive forces of the flowing water. Wooded areas and farm fields provided ample supply of debris causing clogs and damages to culverts, low water crossings and bridges.

In addition to riverine flooding or flooding in poorly drained areas, is the consideration of fluvial erosion hazard (FEH). This represents the risk associated with natural stream movements and losses associated with buildings and infrastructure. In some cases, this may be represented by a gradual movement of a stream across a farm field. In other, more extreme instances, homes or other infrastructure may actually be lost as steep riverbanks or bluffs sluff into the water below. This will be discussed more within the landslide/land subsidence discussion.

Because of the terrain in Brown County heavy rain events, and flash floods in the northern portion of the county have a greater impact than those taking place in the south. Additionally, a different dynamic takes place when flooding also includes Columbus in Bartholomew County. Flooding in Columbus severely limits access to the hospital resulting in the sick and injured having to be transported by land to hospitals to the north or worst case via helicopter. **Figure 18** is an example of inundation mapping developed to identify areas impacted by a Moderate Stage (20ft) flood. Since the last planning effort in 2016, this gage has reached the Moderate Flood stage during six different events.

Figure 18: Inundation Map for North Fork Salt Creek at Nashville - Moderate Stage (19') Flood Event

Within Brown County, direct and indirect effects of a flood event may include:

Direct Effects:

- Structural and content damages and/or loss of revenue for properties affected by increased water
- Increased costs associated with additional response personnel, evacuations, and sheltering needs
- Increased potential impacts to infrastructure and buildings located within the FEH area

Indirect Effects:

- Increased response times for emergency personnel when roads are impassable
- Increased costs associated with personnel to carry out evacuations in needed areas
- Increased risk of explosions and other hazards associated with floating propane tanks or other debris.
- Losses associated with missed work or school due to closures or recovery activities
- Cancellations of special events in impacted areas or water related activities that become too dangerous due to high water

In the time since the last planning effort, significant development has not occurred within the municipalities and populations have not increased. The development and redevelopment that has occurred, has been directed away from the floodplains. This mitigation measure helps to reduce the county-wide flood risk and vulnerability. Structures have prevented from being built in the high-risk areas while growth is being directed to more appropriate areas, less at risk from riverine flooding.

Estimating Potential Losses

Critical and non-critical structures located in regulated floodplains, poorly drained areas, or low-lying areas are most at risk for damages associated with flooding. For this planning effort, a GIS Desktop Analysis methodology was utilized to estimate flood damages.

For the GIS Desktop Analysis method, an analysis was completed utilizing the effective Digital FIRMs (DFIRMs) overlaid upon a Modified Building Inventory developed with information provided by Brown County. Structures located within each flood zone were tallied using GIS analysis techniques.

In the assessment, any structure listed as less than 400 ft² in area or classified in the Assessor's database as a non-habitable structure was assumed to be an outbuilding. It was assumed that a building was located on a parcel if the value listed in the "Assessed Value (Improvements)" showed a value greater than zero dollars. Parcels that intersected any portion of the FEMA flood zones were considered to be flood prone, and subsequently, further analyzed separately from parcels without structures. Structure values were calculated using:

Residential = Assessed Value x 0.5
Commercial = Assessed Value x 1.0
Industrial = Assessed Value x 1.5
Agricultural = Assessed Value x 1.0
Education = Assessed Value x 1.0
Government = Assessed Value x 1.0
Religious = Assessed Value x 1.0

In order to estimate anticipated damages associated with each flood zone in Brown County and communities, it was estimated that 25% of structures in the flood zones would be destroyed, 35% of structures would be 50% damaged, and 40% of structures would be 25% damaged. **Table 14** identifies the estimated losses associated with structures in the floodway, the 1% AEP (100-year floodplain), and the 0.2% AEP (500-year floodplain) areas by community within Brown County.

Table 14: Manual GIS Analysis Utilizing Best Available Data and Brown County Building Inventory

	Floodway		1% AEP		0.2% AEP		Unnumbered	
	#	$	#	$	#	$	#	$
Brown County	226	$36.9M	300	$39.7M	72	$9.1M	140	$18.5M
Nashville	38	$10.4M	50	$7.7M	3	$0.7M	0	0
Totals	**264**	**$47.3M**	**350**	**$47.4M**	**75**	**$9.8M**	**140**	**$18.5M**

Utilizing the same GIS information and process, critical infrastructure within each of the flood hazard areas in Brown County was assessed and are included in **Table 15**. These buildings are included in the overall number of structures and damage estimate information provided in **Table 16**.

Table 15: Critical Infrastructure in Flood Zones in Brown County

Community	Floodway	1% AEP	0.2% AEP
Brown County	Helmsburg WWTP Nashville WWTP	Gnawbone WWTP Shelby Gravel	
Town of Nashville	CVS Pharmacy Brown County Inn	Brown County IGA	

Two additional structures were found within the county in an unnumbered flood area: Van Buren Elementary School and the Van Buren Volunteer Fire Department. Utilizing the information in Table

16 regarding the number of structures within each of the flood hazard areas, it is also important to note the number of flood insurance policies within each area in Brown County. **Table 16** provides the comparison between the number of structures in the 1.0% AEP and the number of flood insurance policies. It is also important to note that flood insurance is voluntary unless the property owner carries a federally subsidized mortgage; insurance coverage may be discontinued when the mortgage is completed.

Table 16: Number of Structures in the 1.0% AEP and Number of Flood Insurance Policies

COMMUNITY	# STRUCTURES IN 1.0% AEP	# POLICIES
Brown County	300	89
Town of Nashville	50	8
Total	**350**	**97**

Future Considerations

As the municipalities within Brown County grow in population and redevelop, it can be anticipated that the number of critical and non-critical infrastructure will also increase accordingly. Brown County updated and recorded the County Floodplain Ordinance in November 2016. Nashville similarly adopted their Floodplain Ordinance in 2017. Both Brown County and Nashville discourage critical facilities such as schools, medical facilities, community centers, municipal buildings, and other critical infrastructure to be located within the 1% AEP (100-year) floodplain. New structures must also be protected to that level along with a flood-free access to reduce the risk of damages caused by flooding and to ensure that these critical infrastructures will be able to continue functioning during major flood events. Flooding due to poor drainage, low-lying land, or flash flooding is also an important consideration. It will be important for recognition of potential flood impacts to residents and businesses in these areas to be coupled with proper planning for future development and redevelopment of the flood zones. This would also include studying the inundation areas mapped through the development of the Nashville Flood Response and Resiliency Plan. Since the previous planning effort, no additional development has occurred within the flood zones of Brown County or the Town of Nashville.

It is important to ensure that owners and occupants of residences and businesses within the known hazard areas, such as delineated or approximated flood zones and FEH, are well informed about the potential impacts from flooding incidents as well as proper methods to protect themselves and their property.

Increased precipitation, as predicted in the Indiana Climate Change Assessment, is anticipated to come in the form of heavier, shorter events which lead to the increased potential for flooding and stress on infrastructure such as sanitary and storm sewers. Heavy precipitation events are anticipated to occur more frequently as temperatures rise, replacing rain when previously there was snow.

Despite these efforts, the overall vulnerability and monetary value of damages is expected to increase in the area unless additional measures, such as those discussed later in Chapter 4 of this report, are implemented.

Figure 19: Fire Engine in Flood Waters

Indirect effects of flooding may include increased emergency response times due to flooded or redirected streets (**Figure 19**), the danger of dislodged and floating propane tanks causing explosions, and the need for additional personnel to carry out the necessary evacuations. Additional effects may include sheltering needs for those evacuated, and the loss of income or revenue related to business interruptions. As many communities within Brown County are closely tied to the tourism sector, special events occurring near to or on these rivers and waterways may be cancelled or postponed during periods of flooding or high-water levels.

Relationship to Other Hazards

While flooding creates social, physical, and economic losses, it may also cause other hazards to occur. For example, flooding may increase the potential for a hazardous materials incident to occur. Above ground storage facilities may be toppled or become loosened and actually migrate from the original location. In less severe situations, the materials commonly stored in homes and garages such as oils, cleaners, and de-greasers, may be mobilized by flood waters. Should access roads to hazardous materials handlers become flooded, or if bridges are damaged by flood waters, response times to more significant incidents may be increased, potentially increasing the damages associated with the release.

Increased volumes of water during a flood event may also lead to a dam failure. As the water levels rise in areas protected by dams, at some point, these structures will over-top or will breach leading to even more water released. These two hazards, flood and dam failure, when combined, may certainly result in catastrophic damages.

In a similar fashion, a snowstorm or ice storm can also lead to flooding on either a localized or regional scale. When a large amount of snow or ice accumulates, the potential for a flood is increased. As the snow or ice melts, and the ground becomes saturated or remains frozen, downstream flooding may occur. Ice jams near bridges and culverts may also result in flooding of localized areas and potentially damage the bridge or culvert itself.

Repeated flooding may also create impacts associated with landslides along riverbanks and bluff areas. As floodwaters travel through the systems, saturating shorelines and increasing volumes and velocities of water, the natural process of fluvial erosion may be exacerbated. As these processes are increased, structures and infrastructure located on bluffs or in proximity to the river may be at risk.

Flooding in known hazard areas may also be caused by dams that experience structural damages or failures not related to increased volumes or velocities of water. These "sunny day failures", while not typical, may occur wherever these structures exist throughout the county.

3.2.6 Hailstorms, Thunderstorms, and Windstorms

Overview

Hail occurs when frozen water droplets form inside a thunderstorm cloud, and then grow into ice formations held aloft by powerful thunderstorm updrafts, and when the weight of the ice formations becomes too heavy, they fall to the ground as hail. Hail size ranges from smaller than a pea to as large as a softball, and can be very destructive to buildings, vehicles (**Figure 20**), and crops. Even small hail can cause significant damage to young and tender plants. Residents should take cover immediately in a hailstorm, and protect pets and livestock, which are particularly vulnerable to hail, and should be under shelter as well.

Thunderstorms are defined as strong storm systems produced by a cumulonimbus cloud, usually accompanied by thunder, lightning, gusty winds, and heavy rains. All thunderstorms are considered dangerous as lightening is one of the by-products of the initial storm. In the United States, on average, 300 people are injured, and 80 people are killed each year by lightning. Although most lightning victims survive, people struck by lightning often report a variety of long-term, debilitating symptoms. Other associated dangers of thunderstorms included tornados, strong winds, hail, and flash flooding.

Windstorms or high winds can result from thunderstorm inflow and outflow, or downburst winds when the storm cloud collapses, and can result from strong frontal systems, or gradient winds (high- or low-pressure systems). High winds are speeds reaching 50 mph or greater, either sustained or gusting.

Recent Occurrences

Figure 20: Damaging Hail on Vehicles

In Brown County, the NCDC has recorded 4 hailstorms and 15 thunderstorms/windstorms between June 2016 and June 2022. The average diameter hail stone occurring throughout Brown County is approximately 1.0 inch with the largest one for this period of interest being 1.5 inches July 7, 2017.

Significant windstorms are characterized by the top wind speeds achieved during the incident, characteristically occur in conjunction with thunderstorms, and have historically occurred year-round with the greatest frequency and damage occurring in May, June, and July. Within Brown County, NCDC reports eleven (11) instances between June 2016 and June 2022 where top wind speeds were greater than 60 mph.

Total NCDC recorded damages for hailstorms, thunderstorms, and windstorms throughout Brown County are $125.20K in property damages, no additional crop damages, and no injuries or deaths associated with these events. Many event reports included in the NCDC did not provide descriptive information on the social, physical, and economic losses resulting from individual storms specific to Brown County. Even in instances where monetary damages were reported, narrative descriptions of the event rarely extended beyond reports of damages to broken tree limbs, downed power lines, or roof damages.

During the April 28, 2017 event in New Bellsville, thunderstorms and heavy winds resulted in a tree falling onto a home trapping a man inside the home. Appendix 6 provides the NCDC information regarding hailstorms, thunderstorms, and windstorms that have resulted in injuries, deaths, and monetary damages to property and/or crops.

According to the Institute for Business and Home Safety, central Indiana can expect to experience damaging hailstorms three to four times over 20 years; the average life of a residential roof. Further, thunderstorms and windstorms are considered a high frequency hazard and may occur numerous times per year.

The Committee determined the probability of a hailstorm, thunderstorm, or windstorm occurring anywhere throughout Brown County ranged from "Likely" to "Highly Likely" and will typically affect broad portions of the county at one time resulting in potentially "Limited" damages. As advancements in technologies such as weather radar systems and broadcast alerts are continually made, the warning time for such incidents may increase. Currently, the Committee feels that the warning time is anticipated to be between six to twelve hours and the duration is expected to last less than one day.

Indicative of a regional hazard, the probability, magnitude, warning time, and duration of a hailstorm, thunderstorm, or windstorm are expected to be similar throughout the county. These events are highly unpredictable, and the occurrences are distributed through the county, sometimes impacting one community more often or more severely than another. Therefore, the CPRI values reflect the distributed risk and associated priority for a hailstorm, thunderstorm, or windstorm. A summary is provided in **Table 17**.

Table 17: CPRI for Hailstorm, Thunderstorm, and Windstorm

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Brown County	**Highly Likely**	**Limited**	**6 - 12 hours**	**< 1 day**	**Severe**
Town of Nashville	**Likely**	**Limited**	**6 - 12 hours**	**< 1 day**	**Severe**

Specific locations and frequency of hailstorms, thunderstorms, and windstorms are difficult to predict as many of these individual events are without significant warning time and may have impacts to very limited areas or may affect broader areas. However, based on NCDC data and personal experiences of the Committee, it was determined that all areas within the County are anticipated to experience a hailstorm, thunderstorm, or windstorm within the calendar year. More likely, these communities will be impacted by several of these hazard events each year. The magnitude is anticipated to be similar based on the number of critical infrastructure and populations of each of the municipalities, or "Limited."

Assessing Vulnerability

The effects of a hailstorm, thunderstorm, or windstorm may be minimal to extensive in nature and may affect small or broad ranges of land area. Within Brown County, direct and indirect effects from a hailstorm, thunderstorm, or windstorm may include:

Direct Effects:

- Damages to infrastructure (power lines)
- Damages to individual properties (homes, cars)

Indirect Effects:

- Downed power lines due to falling tree limbs

- Losses associated with power outages
- Damages sustained from blowing debris
- Cancellation or interruption of special events

Estimating Potential Losses

Figure 21: Home Damaged During Windstorm

Due to the unpredictability of this hazard all critical infrastructure and non-critical structures in Brown County are at risk of damage including temporary or permanent loss of function. For hailstorms, thunderstorms, and windstorms, it is not possible to isolate specific critical infrastructure or non-critical structures that would be vulnerable to damages. However, areas where utility lines are above ground and areas where dead or dying trees have not been removed may be at a higher risk of property damages or power outages during hailstorms, thunderstorms, and windstorms. Additionally, mobile homes and accessory buildings such as pole barns and sheds may also be at a higher risk of damages from hailstorms, thunderstorms, and windstorms if not properly anchored to the ground. Damages from falling limbs or uprooted trees such as that shown in **Figure 23.**

As the populations of the communities in Brown County develop and redevelop, it can be anticipated that the number of critical and non-critical structures will also increase. To reduce the vulnerability for damages resulting from a hailstorm, thunderstorm, or windstorm, measures such as proper anchoring, enforcement of the International Building Codes, and burial of power lines should be completed. While measures can be taken to remove existing structures or prevent future structures from being built in known hazard areas such as floodplains and hazardous materials facility buffers, such measures are not applicable to hailstorms, thunderstorms, and windstorms due to the diffuse nature and regional impacts of this hazard.

Indirect effects resulting from a hailstorm, thunderstorm, or windstorm can include power outages caused by downed tree limbs or flying debris, damages resulting from prolonged power outages, and damages to structures or property as a result of debris.

Relationship to Other Hazards

Hailstorms, thunderstorms, and windstorms may be the precursor for other hazards. For example, hazardous materials incidents can be the result of a hailstorm, thunderstorm, or a windstorm. Material storage containers can become damaged by high winds, debris, or even lightning, and can result in a spill or release of materials. With wind speeds greater than 58 mph, tankers and other transportation vehicles carrying hazardous materials are also at risk while on the road. High winds may also cause gaseous substances to travel farther distances at a much faster rate, increasing the evacuation area necessary to protect residents and visitors of Brown County.

Additionally, rainfall typically occurs with a thunderstorm and this additional precipitation may lead to localized flooding or riverine flooding depending on the amount of rain during the event. Debris from

a windstorm may also lead to localized flooding if debris is deposited over drains or if obstructions are created by downed limbs, trees, or other storm related debris. A similar concern due to the potential precipitation would be dam failure. High winds may place debris near spillways, blocking the emergency drainage mechanism for the dams. High winds may also lead to structural damages to a dam or may cause damages to nearby trees or other structures, leading to indirect damages.

The risk of social losses also increases during a hailstorm, thunderstorm, or windstorm, as these hazards often result in downed power lines, utility poles, and trees. Debris such as this may impede traffic patterns and make it difficult for emergency vehicles (Fire, EMS, and Police) to pass through affected areas or people may be directly injured because of falling or flying debris.

3.2.7 Landslide/Subsidence

Overview

The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors. For example, erosion by rivers, glaciers, or ocean waves can cause rock to fall. Rock and soil slopes may be weakened through saturation by snowmelt or heavy rains, earthquakes can create stresses that make weak slopes fail, and excess weight from accumulation of rain or snow, stockpiling of rock or ore, from waste piles, or man-made structures that may stress weak slopes to the point of collapse.

Another important consideration is FEH. This represents the risk associated with natural stream movements and losses associated with buildings and infrastructure. In some cases, this may be represented by a gradual movement of a stream across a farm field. In other, more extreme instances, homes or other infrastructure may actually be lost as steep riverbanks or bluffs sluff into the water below.

Land subsidence, according to the USGS, is "a gradual settling or sudden sinking of the Earth's surface owing to subsurface movement of earth materials". Further, there are three processes that attribute to subsidence: compaction of aquifer systems, drainage and subsequent oxidation of organic soils, and dissolution and collapse of susceptible rocks.

Recent Occurrences

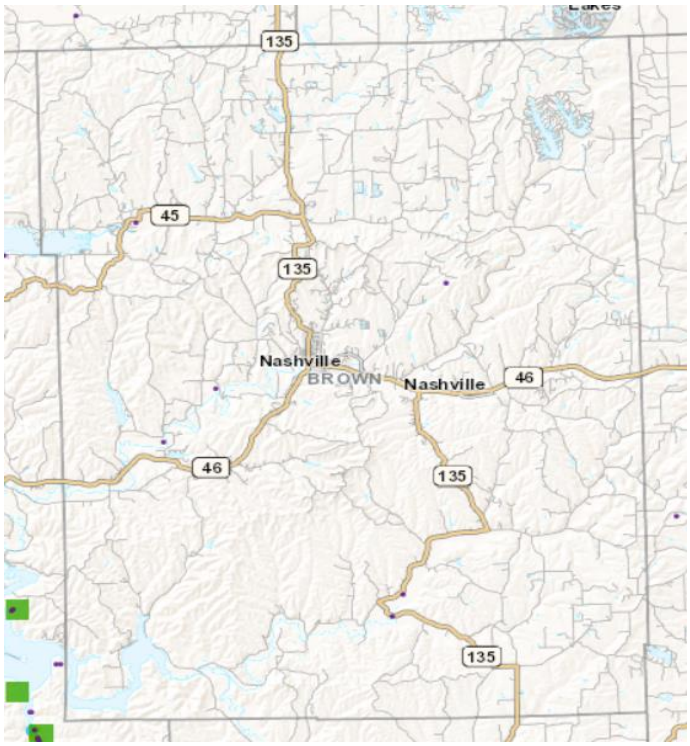


Figure 22: Sinkhole Areas in Brown County, Indiana

The potential for any of landslides or land subsidence within Brown County was discussed by the Planning Committee. As identified through IndianaMap, there are Karst Sinkhole areas dispersed throughout the County (**Figure 22**).

The small purple dots indicate the known sinkholes in the county as of 2011. To the knowledge of the Planning Committee, there are no active underground mining operations within Brown County. In addition of this, to date, there has not been any landslides or subsidence events reported in Brown County.

The Committee determined the probability of a landslide or subsidence occurring in Brown County is "Unlikely" due to the presence of ravines and high banks along some of the water courses. Any event is expected to result in potentially "Negligible" damages. Currently, the Committee feels that the warning time is anticipated to be less than six hours and similarly, the duration is expected to last less than six hours. These events are highly unpredictable and the risk, although very low according to the Committee, is distributed throughout the county. Therefore, the CPRI values reflect the distributed risk and associated priority for a landslide or subsidence event. A summary is provided in **Table 18**.

Table 18: CPRI for Landslide/Land Subsidence

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Brown County	**Unlikely**	**Negligible**	**< 6 hours**	**< 6 hours**	**Low**
Nashville	**Unlikely**	**Negligible**	**< 6 hours**	**< 6 hours**	**Low**

Assessing Vulnerability

Brown County, with the limited presence of Karst geology, is at a low risk of land subsidence or sink holes; "Unlikely" according to the Planning Committee with "Negligible" severity.

The effects of a landslide or subsidence event may be minimal to extensive in nature and may affect small or broad ranges of land area. **Figure 23** identifies the FEMA National Risk Index regarding landslide throughout Indiana and surrounding areas. The risk index considers expected annual loss as well as vulnerabilities by census tract and community resilience. Brown County is highlighted in the center of the figure and is shown to have a Relatively Low risk associated with landslides.

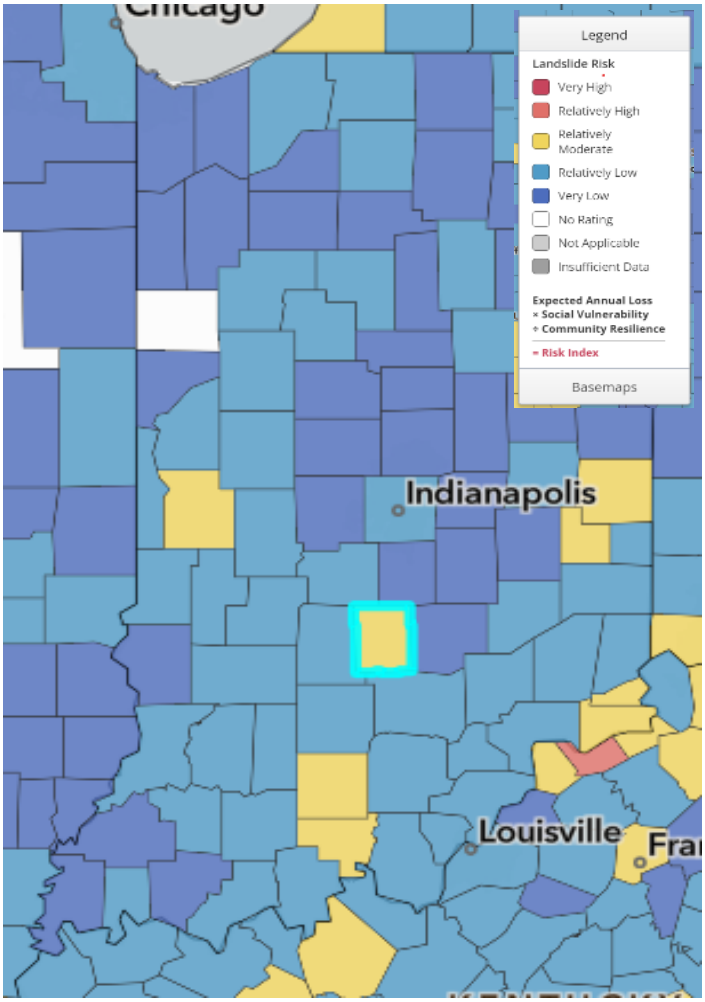


Figure 23: FEMA National Risk Index, Landslide

Within Brown County, direct and indirect effects may include:

Direct Effects:

- Damages to infrastructure (power lines, roads, bridges)
- Damages to individual properties (homes, cars)

Indirect Effects:

- Increased response time for emergency vehicles
- Losses associated with affected land (crop loss)
- Potential contamination of groundwater resources

Estimating Potential Losses

Due to the unpredictability of this hazard all critical infrastructure and non-critical structures in Brown County are at risk of damage including temporary or permanent loss of function. For landslide and subsidence, it is difficult to isolate specific critical infrastructure or non-critical structures that would be more or less vulnerable to damages. However, areas where karst geology have been identified may be at a higher risk of property damages caused by such events. To prepare a basic "what-if" scenario, the Indiana karst geology GIS layers were overlaid onto parcel data

provided by the County. **Table** identifies the number of structures and potential damages within the karst areas.

Table 19: Summary of Structures in Karst Areas

Community	Potential Damages	
	# Structures	$ Damages
Brown County	1,584	$126.1M
Town of Nashville	40	$2.9M

Future Considerations

As the populations of the communities in Brown County grow, it can be anticipated that the number of critical and non-critical structures will also increase. In order to reduce the vulnerability for damages resulting from a landslide or land subsidence, FEH areas, soils and mining GIS layers should be integrated into the building permit or approval process. In recent years, no significant development has occurred within these areas of Brown County. However, depending on the location, any development may increase the vulnerability to this hazard.

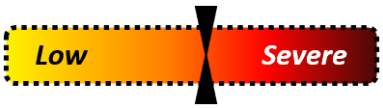
Indirect effects resulting from a landslide or land subsidence event can include power outages caused by downed tree limbs, increased response times for emergency personnel if transportation routes are damaged, and potentially shot down of businesses.

Relationship to Other Hazards

A landslide or a subsidence may be the precursor for other hazards. Depending on the location of the event, material storage containers can become damaged resulting in a spill or release of materials and potentially contaminating groundwater reserves. Dam failures may occur in much the same fashion if located in the potential hazard areas, or resulting from heavy saturation following a rainstorm, heavy snow, or rapid snow melt.

Similarly, these types of events may be caused by hail, thunder, or windstorms and their effects on the soils; an earthquake may release the ground enough to set a slide in motion; or a flood may add increased soil saturation or weight to at-risk areas increasing the potential for an event and resulting damages.

3.2.8 Tornado



Overview

Tornadoes are defined as violently rotating columns of air extending from thunderstorms to the ground. Funnel clouds are rotating columns of air not in contact with the ground. However, the funnel cloud may reach the ground very quickly – becoming a tornado. If there is debris lifted and blown around by the "funnel cloud", then it has reached the ground and is a tornado.

Figure 24: Funnel Cloud During a Lightning Storm at Night

A tornado is generated when conditions in a strong cell are produced that exhibit a wall of cool air that overrides a layer of warm air. The underlying layer of warm air rapidly rises, while the layer of cool air drops – sparking the swirling action. The damage from a tornado is a result of the high wind velocity and wind-blown debris. Tornado season is generally April through June in Indiana, although tornadoes can occur at any time of year. Tornadoes tend to occur in the afternoons and evenings; over 80 percent of all tornados strike between 3:00 pm and 9:00 pm but can occur at any time of day or night as shown in Error! R eference source not found. Tornadoes occur most frequently in the United States east of the Rocky Mountains. Tornadoes in Indiana generally come from the south through the east. While most tornadoes (69%) have winds of less than 100 mph, they can be much stronger. Although violent tornadoes (winds greater than 205 mph) account for only 2% of all tornadoes, they cause 70% of all tornado deaths. In 1931, a tornado in Minnesota lifted an 83-ton rail car with 117 passengers and carried it more than 80 feet. In another instance, a tornado in Oklahoma carried a motel sign 30 miles and dropped it in Arkansas. In 1975, a Mississippi tornado carried a home freezer more than a mile.

Recent Occurrences

The classification of tornadoes utilizes the Enhanced Fujita Scale of tornado intensity and damages. Tornado intensity ranges from low intensity (EF0) tornadoes with effective wind speeds of 65-85 mph to high intensity (EF5+) tornadoes with effective wind speeds of 200+ mph. According to the NCDC, Brown County has experienced one tornado, an EF0, between June 1, 2015 and February 28, 2022.

Table 20: Enhanced Fujita Scale of Tornado Intensity

EF-Scale	Winds	Character of Damage	Relative Frequency	Typical Damages
EF0	65-85 mph	Light damage	29%	Shallow rooted trees blown over; damage to roofs, gutters, siding
EF1	86-110 mph	Moderate damage	40%	Mobile homes overturned, roofs stripped, windows broken
EF2	111-135 mph	Considerable damage	24%	Large trees snapped, light-object missiles generated, cars lifted
EF3	136-165 mph	Severe damage	6%	Severe damages to large buildings, trains overturned
EF4	166-200 mph	Devastating damage	2%	Whole houses destroyed; cars thrown
EF5	200+ mph	Incredible damage	<1%	High-rise buildings with significant damage, strong framed homes blown away

The NCDC reports approximately $1.0K in property damages and no injuries or deaths related to the tornado which occurred in this reporting period. June 15, 2019, the EF0 tornado briefly touched down south of SR 135 near Story, IN and caused minor damage to a tree in the area.

The Committee estimated the probability of a tornado occurring in Brown County would be "Possible" and the magnitude and severity of such an event to be "Limited" throughout the unincorporated county and "Critical" in the Town of Nashville. As with many hazardous events, the Committee anticipated a short warning time of typically less than six hours, and a short duration, also less than six hours. The summary is shown in **Table 19**.

Table 19: CPRI for Tornado

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Brown County	**Possible**	**Limited**	**< 6 hours**	**< 6 hours**	Elevated
Nashville	**Possible**	**Critical**	**< 6 hours**	**< 6 hours**	Elevated

The Indiana State Climate Office estimates that throughout Indiana, there is an average of 20 tornado touchdowns per year. Based on the number of tornado touchdowns previously reported through the NCDC and local weather agencies, the Committee determined the general probability of a future tornado occurring in Brown County is "Possible" (within the next five years).

Assessing Vulnerability

As a path of a tornado is not pre-defined, it is difficult to isolate specific critical infrastructure and non-critical structures, or areas of Brown County that would be vulnerable to a tornado. Direct and indirect effects from a tornado may include:

Direct Effects:

- Damages to older construction structures, mobile homes, and accessory structures (pole barns, sheds, etc.)
- Damages to above ground utility lines and structures

Indirect Effects:

- Expenses related to debris clean-up and/or reconstruction
- Loss of revenue for affected businesses
- Loss of work if employers are affected

Estimating Potential Losses

Due to the unpredictability of this hazard, all critical and non-critical structures within the county are at risk of future damage or loss of function. Estimates of potential physical losses were determined through a hypothetical exercise where an EF2 intensity tornado traveled through portions of the county and the communities. This is intended to present a "what-if" scenario of a tornado incident and associated damages. Damage estimates were derived by assuming that 25% of all structures in the path of the tornado would be completely destroyed, 35% of the structures would be 50% damaged, and 40% of the structures would sustain 25% damage. These estimations were also determined utilizing three wind speed zones based on distance from the tornado path. Zone 1 is nearest the center of the tornado path, while Zone 3 is the farthest from the path and with a theoretically lower wind speed. **Table 20** provides summary data for the hypothetical tornado, which is identified on Exhibit 3.

Table 20: Summary of Hypothetical Tornado Damages

	Zone 1		Zone 2		Zone 3		Total	
	#	$	#	$	#	$	#	$
Nashville	29	$3.8M	17	$3.7M	39	$7.6M	**85**	**$15.1M**
Brown County	50	$11.6M	40	$9.3M	44	$7.6M	**134**	**$36.1M**
Totals	**79**	**$15.4M**	**57**	**$13.0**	**83**	**$15.2M**	**581**	**$51.2M**

Utilizing the same GIS information and process, critical infrastructure within each of the hypothetical tornado zones are included in **Table 21**. These buildings are included in the over number and of structures and damage estimate information provided in Table 24.

Table 21: Critical Infrastructure in Tornado Zones

Community	Zone 1	Zone 2	Zone 3
Brown County			Nashville WWTP
Nashville	Brown County Junior High School, Brown County High School	Artists Colony Inn, Nashville Elementary School, Brown County VFD, Speedway Gas Station	CVS Pharmacy, Nashville Police Department

Future Considerations

Within Brown County, there are numerous events each year as well as the regular tourist attractions that draw thousands of guests. Due to this, it is imperative that the EMA place continued importance on the need to maintain their outdoor warning siren coverage. Because of the hilly terrain, it is challenging to find the best location for outdoor warning siren coverage. Currently, other more densely populated areas of the county are not covered by the audible ranges of the existing outdoor warning

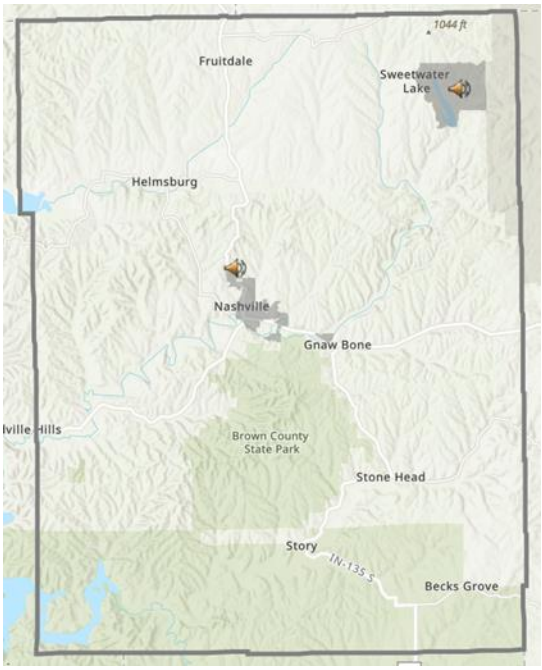


Figure 25: Brown County Outdoor Warning Sirens

sirens. The existing siren locations are identified in **Figure 27.** While it can be anticipated that new construction associated with development may be stronger than older or existing construction, existing older structures, barns, pole buildings, silos and mobile homes remain threatened by tornados. The unincorporated portions of Brown County will remain vulnerable in areas the outdoor warning siren coverage is not present. It is impossible to predict the path of a tornado and therefore all current and future development will continue to be at risk for damages. Risks to the citizens of Brown County have been lessened through participation in mass notification programs. Increased participation in the mass warning notification system, Everbridge, is encouraged for all residents of the county.

There may also be indirect effects of a tornado event. For example, post-event clean-up may result in high expenses or inability to work for property owners that have experienced damages from either the tornado directly or by debris from high winds. Affected business owners may experience loss of revenue if they are unable to continue operations following the event. Similarly, if a business is affected and unable to operate, employees may experience a loss of wages during the period of recovery. Lastly, if damages occur in or near the Town of Nashville, tourist activities and events would potentially be cancelled resulting in a decreased income for the local businesses and shops.

Relationship to Other Hazards

Tornadoes may result in a hazardous materials incident. Material storage containers can become damaged by high winds and debris can result in a spill or release of materials. As wind speeds increase, the potential for damages to above ground storage containers also increases. Tankers and other transportation vehicles carrying hazardous materials are also at an increased risk while on the road or rail.

Tornadoes may also result in a dam failure as the increased wind speeds, and debris caused by the tornado, may directly impact the dam, or cause indirect damages through large debris or downed trees. In addition, tornadoes may lead to structural fires as the destruction path is sometimes long and broad, leading to an increased number of potentially damaged homes, exposed power lines, and large amounts of debris.

3.2.9 Winter Storm and Ice

Overview

A winter storm can range from moderate snow over a few hours to blizzard conditions with high winds, ice storms, freezing rain or sleet, heavy snowfall with blinding wind-driven snow, and extremely cold temperatures that can last for several days. Some winter storms may be large enough to affect several states while others may affect only a single community. Winter storms are typically accompanied by cold temperatures and blowing snow, which can severely reduce visibility. A winter storm is defined as one that drops four or more inches of snow during a 12-hour period, or six or more inches during a 24-hour span. An ice storm occurs when freezing rain falls from clouds and freezes immediately on contact with a variety of surfaces. All winter storms make driving and walking extremely hazardous. The aftermath of a winter storm can affect a community or region for days, weeks, and even months.

Figure 26: Ice Covered Power Lines

Storm effects such as extreme cold, flooding, and snow and ice accumulation can cause hazardous conditions and hidden problems for people in the affected area. **Figure 26** shows the added weight on trees and ice coated powerlines. People can become stranded on the road or trapped at home, without utilities or other services, including food, water, and fuel supplies. The conditions may overwhelm the capabilities of a local jurisdiction. Winter storms are considered deceptive killers as they may indirectly cause transportation accidents, and injury and death resulting from exhaustion/ overexertion, hypothermia and frostbite from wind chill, and asphyxiation. House fires occur more frequently in the winter due to lack of proper safety precautions.

Wind chill is a calculation of how cold it feels outside when the effects of temperature and wind speed are combined. On November 1, 2001, the NWS implemented a replacement Wind Chill Temperature (WCT) index for the 2001/2002 winter season. The reason for the change was to improve upon the current WCT Index, which was based on the 1945 Siple and Passel Index.

A winter storm watch indicates that severe winter weather may affect your area. A winter storm warning indicates that severe winter weather conditions are on the way. In the event of a blizzard, a winter storm warning will be issues and include the details of the blizzard - that large amounts of falling or blowing snow and sustained winds of at least 35 mph are expected for several hours. Winter storms are common in Brown County and the surrounding region. Such conditions can result in substantial personal and property damage, even death. The National Weather Service recently (October 15, 2018) consolidated their watch and warning products. In doing so, blizzards and lake effect snows are no longer separate watches and warnings, but instead are detailed as a part of winter storm watches and warnings.

Recent Occurrences

Since June 2015, the NCDC has recorded two heavy snow events, one ice storm, and one winter storm. NCDC reports indicated $15.0K in property damages, no additional crop damages and no injuries, or

deaths associated with any of the events. Many narrative descriptions indicated poor travel conditions, power outages and debris associated with similar events.

The Indianapolis National Weather Service reported that an upper-level low brought a wintry mix of snow, sleet, and freezing rain to central Indiana the evening of November 14 into the early morning hours of November 15. The wintry mix created hazardous travel conditions, caused power outages affecting over 60,000 people (according to Indiana Department of Energy), and caused damage to trees. Over 680 people were without power and several roads were closed due to power lines and trees down from ice accumulation of approximately ¼ inch. The snow which followed the ice ranged from 4 to 8 inches in accumulation and travel were advisories issued.

The probability, magnitude, warning times, and duration of a snowstorm or ice storm causing disruption to residents and businesses in Brown County, as determined by the Planning Committee, is expected to be mostly consistent throughout the county and communities. It is "Possible" that this type of hazard will occur in this area and will typically affect the entire county, and possibly several surrounding counties at one time, resulting in primarily "Limited" damages. The warning time for severe temperatures or several inches of snow associated with a winter storm is usually 12-24 hours while the duration of the incident is anticipated to be greater than one day. A summary is shown in **Table 22**.

Table 22: CPRI for Winter Storm and Ice

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Brown County	**Possible**	**Limited**	**12 - 24 hours**	**< 1 day**	Low
Nashville	**Possible**	**Limited**	**12 - 24 hours**	**< 1 day**	Low

The Planning Committee determined that the probability for a snowstorm or ice storm to occur in Brown County and the communities within is "Possible" or may occur within each calendar year. Based on historical data and the experience of the Planning Committee, snowstorms are not very frequent within Brown County, but actions have been taken to mitigate many impacts from snow and ice storms complicated by to the hilly terrain. The Committee considered only the larger, more detrimental event for this effort.

Assessing Vulnerability

A snowstorm typically affects a large regional area with potential for physical, economic, and/or social losses. Direct and indirect effects of a snowstorm or ice storm within Brown County may include:

Direct Effects:

- Higher number of businesses rely on outside workforce and may experience loss of production as employees may not be able to get to work. The high number of residents traveling to other areas for work results in loss of income due to the inability to reach their normal worksites.
- Rural (County) roads may impassable
- Expenses related to snow removal or brine/sand applications
- Weight of ice and wet snow impacts older structures roofs as well as powerlines
- Large ice and snow events interrupt economic activity within the community.

Indirect Effects:

- Loss of revenue as businesses are closed
- Increased emergency response times based on safety of roads
- Loss of income if unable to get to place of employment
- Delayed impacts due to supply chain disruptions – products not received or shipped on time causes lost wages and revenues.
- Cancellation of special events and reduced tourist activities impact the local economy

Estimating Potential Losses

Given the nature and complexity of a regional hazard such as a snowstorm, it is difficult to quantify potential losses to property and infrastructure. As a result, all critical and non-critical structures and infrastructure are at risk from snowstorm and ice storm incidents.

Figure 27: Travel Impacted During Snowstorm

For planning purposes, information collected in snowstorms impacting other communities around the nation is also useful in assessing the potential social, physical, and economic impact that a winter storm could have on Brown County communities. For example, a March 2003 snowstorm in Denver, Colorado dropped approximately 31 inches of snow and caused an estimated $34M in total damages. In addition, a February 2003 winter storm dropped an estimated 15-20 inches of snow in parts of Ohio. The Federal and Ohio Emergency Management Agencies and U.S. Small Business Administration surveyed damaged areas and issued a preliminary assessment of $17M in disaster related costs. These costs included snow and debris removal, emergency loss prevention measures, and public utilities repair. The agencies found over 300 homes and businesses either damaged or destroyed in six counties. Snowstorms and blizzards also make road travel difficult and dangerous, as in **Figure 27**.

Looking a bit closer to home, In December 2008, Allen County a wintry combination freezing rains, snow and ice. This storm was the largest disaster for Indiana Michigan Power with 110,000 Allen County customers without power. One thousand six hundred (1,600) additional crew members were brought in to restore electrical service to the county. According to the Journal Gazette $10 – $12 million was spent to clean up the debris, make repairs and labor costs for this event.

While the above examples indicate the wide-ranging and large-scale impact that winter storms can have on a community or region, winter storms generally tend to result in less direct economic impacts than many other natural hazards. According to the Workshop on the Social and Economic Impacts of Weather, which was sponsored by the U.S. Weather Research Program, the American Meteorological Society, the White House Subcommittee on Natural Disaster Relief, and others, winter storms resulted in an average of 47 deaths and more than $1B in economic losses per year between 1988 and 1995. However, these totals account for only 3% of the total weather-related economic loss and only 9% of fatalities associated with all weather-related hazards over the same period.

Future Considerations

As populations increase and communities continue to grow, the need to respond to snowstorms or ice storms will remain an important municipal effort. As new construction or re-development occurs, especially new or existing critical infrastructure, it is important to ensure that these new structures are equipped to deal with the potential risks associated with this hazard. Those may include lengthy power outages and potentially impassable transportation routes, making it difficult to obtain supplies or for passage of response vehicles. These hazard events will typically affect the entire county, perhaps multiple counties, and therefore all development, current and future, will be at risk for damages associated with snow and ice storms.

Winter storms can also result in substantial indirect costs. Increased emergency response times, loss of work or the inability to get to work, as well as business interruption, are possible indirect effects of a winter storm. According to a report by the National Center for Environmental Predictions, the cold and snowy winter in late 1977 and early 1978, which impacted several heavily populated regions of the country, was partially responsible for reducing the nation's Gross Domestic Product (GDP) from an estimated growth rate of between 6% and 7% during the first three quarters of 1977 to approximately -1% in the last quarter of 1977 and 3% during the first quarter of 1978.

Relationship to Other Hazards

Figure 28: Flooding Caused by Snow Melt

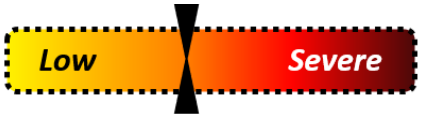
Winter storms and ice storms can lead to flooding as the precipitation melts and enters local receiving waters. This increased volume of water on already saturated, or still frozen ground can quickly result in flood-related damages to structures and properties (**Figure 28**) as well as within the stream or river channel. The increased flooding may then lead to a dam failure within the same area, further exacerbating the damages.

Hazardous materials incidents may be caused by poor road conditions during winter storms or ice storms. Many hazardous materials are transported by rail or by tanker over highways and interstates. In the more rural areas of Brown County, or where open areas are more susceptible to snow drifts on roads, the possibility of a traffic related hazardous materials incident may increase.

Power outages and other infrastructure failures may also occur during a winter storm. Weight from snow and ice accumulations can directly or indirectly cause power lines to fail. During extreme cold temperatures, power outages may prove deadly for certain populations such as the elderly or ill. Power outages in the winter are especially critical as families try to generate heat using alternative heat sources.

TECHNOLOGICAL HAZARDS

3.2.10 Dam Failure



Overview

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

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

Of the approximately 80,000 dams identified nationwide in the National Inventory of Dams, the majority are privately owned. Each dam is assigned a downstream hazard classification based on the potential loss of life and damage to property should the dam fail. The three classifications are high, significant, and low. With changing demographics and land development in downstream areas, hazard classifications are updated continually. The following definitions of hazard classification currently apply to dams in Indiana:

- High Hazard Dam: a structure, the failure of which, may cause the loss of life and serious damage to homes, industrial and commercial buildings, public utilities, major highways, or railroads.
- Significant Hazard Dam: a structure, the failure of which, may damage isolated homes and highways or cause the temporary interruption of public utility services.
- Low Hazard Dam: a structure, the failure of which, may damage farm buildings, agricultural land, or local roads.

A levee is a flood control structure designed to hold water away from a building. Levees protect buildings from flooding as well as from the force of water, from scour at the foundation, and from impacts of floating debris. The principle causes of levee failure are like those associated with dam failure and include overtopping, surface erosion, internal erosion, and slides within the levee embankment or the foundation walls. Levees are designed to protect against a particular flood level and may be overtopped in a more severe event. When a levee system fails or is overtopped, the result can be catastrophic and often more damaging than if the levee were not there, due to increased elevation differences and water velocity. The water flowing through the breach continues to erode the levee and increases the size of the breach until it is repaired or water levels on the two side of the levee have equalized.

Recent Occurrences

Within Brown County, there are eighty-five (85) DNR-regulated dams. Of the eighty-five dams (85), twenty-eight (28) are regulated by DNR as high hazard dams, twenty-eight (28) are regulated as significant hazard dams by DNR, and the remaining twenty-nine (29) are regulated by DNR as low hazard dams. Locations of the dams are shown on Exhibit 2. According to local information, there have not been any recent dam failures within Brown County.

According to the National Levee Database (NLD) managed by the USACE, there are no levees systems within Brown County. Therefore, levees will not be considered as a hazard within this planning effort.

Based on the information provided to them and their local knowledge, experience, and expertise, the Committee determined the probability of a dam failure is "Possible". The magnitude of a dam failure ranges from "Limited" damages. For a dam failure that occurs on a sunny day, the warning time is anticipated to be less than six hours. **Table 23** provides a summary of the Planning Committee's expectations during a dam failure.

Table 23: CPRI for Dam Failure

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
County	**Possible**	**Limited**	**< 6 hours**	**< 6 hours**	Elevated
Nashville	**Possible**	**Limited**	**< 6 hours**	**< 6 hours**	Elevated

Assessing Vulnerability

The actual magnitude and extent of damages due to a dam failure depend on the type of breach, the volume of water that is released, and the width of the floodplain valley to accommodate the flood wave. Due to the conditions beyond the control of the dam owner or engineer, there may be unforeseen structural problems, natural forces, mistakes in operation, negligence, or vandalism that may cause a structure to fail. Fortunately, all the DNR-regulated high hazard dams in the county, except Magness Lake Dam #1 and Reverend Frame Lake have Incident and Emergency Action Plans developed.

Within Brown County, direct and indirect effects from a dam failure may include:

Direct Effects:

- Loss of life and serious damage to downstream homes, industrial and commercial buildings, public utilities, major highways, or railroads
- Loss of use of reservoirs for flood control, recreation, and water supply

Indirect Effects:

- Loss of land in the immediate scour area
- Increased response times due to damaged or re-routed transportation routes and/or bridges

Estimating Potential Losses

As of July 1, 2022, the State of Indiana is requiring High Hazard dams to have Incident and Emergency Action Plans (IEAPs) developed. These plans have detailed potential dam failure inundation areas identified along with at-risk structures identified. All but two (2) of the DNR-regulated High Hazard dams within Brown County, Magness Lake Dam #1 and Reverend Frame Lake Dam, have full IEAPs developed. The actual magnitude and extent of damages depends on the type of dam break, the volume of water that is released, and the width of the floodplain valley to accommodate the dam break flood wave.

The potential fair weather dam failure inundation areas for eleven (11) high hazard dams were reviewed along with recent aerial photography to estimate the number of critical and non-critical structures potentially affected. As with previous hazards, damage estimates were derived by assuming 25% of all structures would be completely destroyed, 35% would be 50% damaged, and the remaining 40% of

structures would have only 25% in damages. **Table 24** provides overview information of each of the individual dam failures.

Table 24: Brown County Potential Dam Failure Impacts

Dam	IEAP	Condition	Structures	Condition
Autumn Lake	Yes	Poor	13	$1.5M
Baker Lake	Yes	Poor	15	$2.0M
Bittersweet Lake	Yes	Poor	9	$1.1M
Logterman Lake Dam	Yes	Poor	4	$0.4M
Magness Lake Dam #1	No	Poor	8	$0.8M
Miller Lake Dam	Yes	Poor	7	$0.8M
Ogle Lake Dam	Yes	Poor	7	$0.8M
Reverend Frame Lake Dam	No	Poor	13	$1.6M
Tousley Dam	Yes	Poor	2	$0.2M
Wright Lake Dam	Yes	Poor	6	$0.8M
Yarling Lake Dam	Yes	Poor	11	$1.2M

Utilizing the same GIS process, it was determined that depending upon the dam location and the circumstances of failure, some critical infrastructures lie within the potential dam failure inundation area in Brown County. Due to the hilly terrain, multiple dams inundate the same areas. For example, the Town of Nashville is in the inundation area of over 20 dams (**Figure 29**) This inunadation area includes the two state roads, the high school and middle school, the jail, Brown County EMA office, Brown County EMS station, CVS Phamacy, Brown County Inn, as well as a large poriton of the downtown businesses.

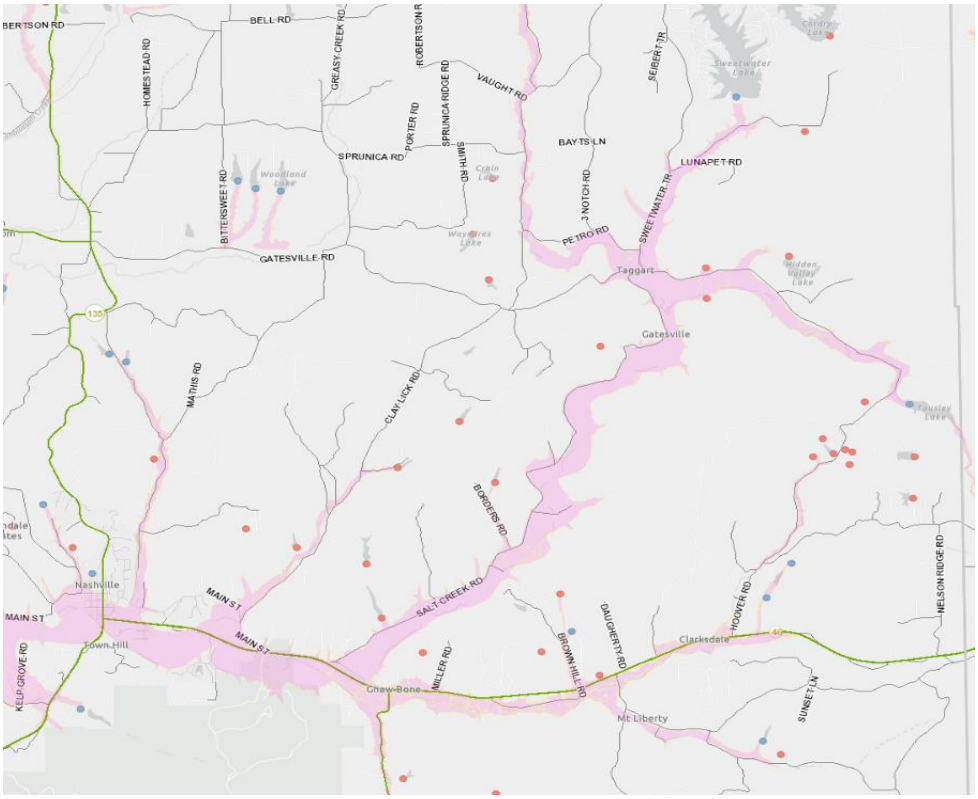


Figure 31: Dam Inundation Areas Impacting the Town of Nashville

Future Considerations

As areas near existing dams continue to grow in population, it can be anticipated that the number of critical and non-critical structures could also increase accordingly. Location of these new facilities should be carefully considered, and precautions should be taken to ensure that schools, medical facilities, municipal buildings, and other critical infrastructure are located outside of the delineated or estimated dam failure inundation areas. Also, flood-free access should be provided for these facilities. Large areas of new development have not yet occurred downstream of the high hazard dams in Brown County. Until such development or re-development downstream of a dam is prohibited, those areas remain vulnerable to losses and damages associated with a failure of that structure. Because of the far-reaching impacts, the committee members identified Sweetwater dam to be their most critical structure.

It is also very important to all downstream communities and property owners that dam IEAPs are developed, kept up-to-date, and routinely exercised to ensure the greatest safety to those within the hazard area. This is a good suggestion even for Significant Hazard dams as well.

Relationship to Other Hazards

With the potentially large volumes and velocities of water released during a breach, it can be expected that such a failure would lead to flooding within the inundation areas downstream of the dam. Nearby bridges and roads are also in danger of being destroyed or damaged due to a dam failure. Bridges may become unstable and portions of road surfaces may be washed away, or the entire road may be undermined. Other infrastructure such as utility poles and lines may be damaged as the water flows along the surface or pipes may become exposed due to scouring; all of which may lead to utility failures within the area downstream of the dam failure.

3.2.11 Hazardous Materials Incident

Overview

Hazardous materials are substances that pose a potential threat to life, health, property, and the environment if they are released. Examples of hazardous materials include corrosives, explosives, flammable materials, radioactive materials, poisons, oxidizers, and dangerous gases. Despite precautions taken to ensure careful handling during manufacture, transport, storage, use, and disposal, accidental releases are bound to occur. These releases create a serious hazard for workers, neighbors, and emergency response personnel. Emergency response to a release may require fire, safety/law enforcement, search and rescue, and hazardous materials response units.

Figure 30: Drums of Potentially Hazardous Waste

As materials are transported for treatment, disposal, or transport to another facility, all infrastructure, facilities, and residences near the transportation routes are at an elevated risk of being affected by a hazardous materials release. Often these releases can cause serious harm to Brown County and its residents if proper and immediate actions are not taken. Most releases are the result of human error or improper storage (**Figure 30**), and corrective actions to stabilize these incidents may not always be feasible or practical in nature.

Railways often transport materials that are classified as hazardous and preparations need to be made and exercised for situations such as derailments, train/vehicle crashes, and/or general leaks and spills from transport cars.

Recent Occurrences

During conversations with Committee members and through information provided by local news outlets, it was noted that numerous small and moderately sized incidents involving manufacturing facilities and transportation routes have occurred since the development of the original MHMP. However, the number of facilities utilizing, storing, and/or manufacturing chemicals and the number of high-volume transportation routes (State Roads 45, 46 and 135 as well as the Indiana Rail Road Company) increase the likelihood of an incident.

According to the Committee, the probability of a hazardous materials release or incident is "Possible" in all areas due to the number of facilities and transportation routes within and through county. "Limited" damages are anticipated to result from an incident. The level of damages is dependent upon the location of the event. As with hazards of this nature, a short warning time of less than six hours and a short duration, also less than six hours is anticipated in the event of a hazardous materials incident. A summary is shown in **Table 25**.

Table 25: CPRI For Hazardous Materials Incident

	Probability	Magnitude/ Severity	Warning Time	Duration	CPRI
Brown County	**Possible**	**Limited**	**< 6 hours**	**< 6 hours**	Elevated
Town of Nashville	**Possible**	**Limited**	**< 6 hours**	**< 6 hours**	Elevated

Relatively small hazardous materials incidents have occurred throughout Brown County in the past and may, according to the Committee, occur again. As the number of hazardous materials producers, users, and transporters increase within or surrounding Brown County, it can be anticipated that the likelihood of a future incident will also increase.

Assessing Vulnerability

Within Brown County, direct and indirect effects from a hazardous materials incident may include:

Direct Effects:

- The Town of Nashville, being a more densely populated area, with a larger number of structures, larger number of chemical storage facilities, and heavily traveled routes is more vulnerable.
- The rural areas may find greater amounts agricultural chemicals, deliveries and storage along with railroad crossings that are affected by such events.
- Expense of reconstruction of affected structures

Indirect Effects:

- Loss of revenue or production while testing, recovery and/or reconstruction occurs
- Anxiety or stress related to event
- Potential evacuation of neighboring structures or facilities
- Expenses incurred due to response, testing, and cleaning of the affected areas.

Figure 31: Fuel Tanker Fire

While the possibility of an incident occurring may be possible, the vulnerability of Brown County has been lowered due to the enactment of Superfund Amendments and Reauthorization Act (SARA) Title III national, state and local requirements. SARA Title III, also known as the Emergency Planning and Community Right to Know Act (EPCRA), establishes requirements for planning and training at all levels of government and industry. EPCRA also establishes provisions for citizens to have access to information related to the type and quantity of hazardous materials being utilized, stored, transported or released within their communities.

One local result of SARA Title III is the formation of the Local Emergency Planning Committee (LEPC). This committee has the responsibility for preparing and implementing emergency response plans, cataloging Safety Data Sheets (SDS) formerly known as Material Safety Data Sheets (MSDS), creating chemical inventories of local industries and businesses, and reporting materials necessary for compliance.

In Brown County, 14 facilities are subject to SARA Title III provisions due to the presence of listed hazardous materials in quantities at or above the minimum threshold established by the Act. These facilities are also required to create and distribute emergency plans and facility maps to local emergency responders such as the LEPC, fire departments, and police departments. With this knowledge on hand,

emergency responders and other local government officials can be better prepared to plan for an emergency and the response it would require, and to better prevent serious effects to the community involved.

Estimating Potential Losses

In addition, the very nature of these events makes predicting the extent of their damage very difficult. A small-scale spill or release might have a minor impact and would likely require only minimal response efforts. Another slightly larger incident might result in the disruption of business or traffic patterns, and in this situation, might require active control response measures to contain a spill or release. However, even small or moderate events could potentially grow large enough that mass evacuations or shelter in place techniques are needed, multiple levels of response are utilized, and additional hazards such as structural fires and/or additional hazardous materials releases (or explosions) may occur. Given the unpredictable nature of hazardous materials incident, an estimate of potential losses was not generated.

Future Considerations

Additional facilities, both critical and non-critical in nature may be affected if a hazardous materials release were to occur along a transportation route. Several routes including railways, State Routes 42, 45, 46, and 135 are traveled by carriers of hazardous materials.

By restricting development within the known hazardous materials facility buffer zones, future losses associated with a hazardous materials release can be reduced. Critical infrastructure should be especially discouraged from being located within these areas. Further, by restricting construction in these zones, the number of potentially impacted residents may also be greatly reduced, lowering the risk for social losses, injuries, and potential deaths. Future construction of hazardous materials facilities should be located away from critical infrastructure such as schools, medical facilities, municipal buildings, and daycares. Such construction would likely reduce the risk to highly populated buildings and populations with physical or social, emotional or behavioral challenges or considerations such as children, elderly, and medically fragile individuals.

Many facilities constructed within close proximity to a hazardous materials facility are similar due to local zoning ordinances. This reduces the risk and vulnerability of some populations. However, there are several facilities and numerous transportation routes located throughout each of the community making current and future development at risk for losses associated with a hazardous materials release.

Relationship to Other Hazards

Dependent on the nature of the release, conditions may exist where an ignition source such as a fire or spark ignites a flammable or explosive substance. As the fire spreads throughout the facility or the area, structural and/or property damages will increase. Response times to a hazardous materials incident may be prolonged until all necessary information is collected detailing the type and amount of chemicals potentially involved in the incident. Depending on the nature of the incident, further delays may take place until qualified Hazardous Materials Responders with the appropriate response and monitoring equipment can be transported to the incident location. While this may increase structural losses, it may decrease the social losses such as injuries or even deaths.

3.3 HAZARD SUMMARY

For the development of this MHMP, the Committee utilized the CPRI method to prioritize the hazards they felt affected Brown County. Hazards were assigned values based on the probability or likelihood of occurrence, the magnitude or severity of the incident, as well as warning time and duration of the incident itself. A weighted CPRI was calculated based on the percent of the county's population present in the individual communities. **Table 26** summarizes the CPRI values for the various hazards studied within this MHMP.

Table 26: Combined CPRI

Type of Hazard	List of Hazards	Weighted Average CPRI
Natural	Drought	
	Earthquake	
	Extreme Temperatures	
	Wildfire	
	Flood – Flash and Riverine	
	Hail/Thunder/Windstorm	
	Landslide/Subsidence	
	Tornado	
	Winter Storm/Ice	
Technological	Dam Failure	
	Hazardous Materials Incident	

It can be important to understand the cause-and-effect relationship between the hazards selected by the Committee. **Table** can be utilized to identify those relationships. For example, a winter storm (along the side of the table) can result in a flood (along the top of the table). In a similar fashion, a hazardous materials incident (along the top of the table) can be caused by an earthquake; flood; tornado; or a winter storm or ice storm (along the side of the table)

Table 29: Hazard Relationship Table

EFFECT → / CAUSE ↓	Drought	Earthquake	Extreme Temperature	Wildfire	Flood	Hailstorm/ Thunderstorm /Windstorm	Landslide / Subsidence	Tornado	Winter Storm / Ice	Dam Failure	Hazardous Materials
Drought											
Earthquake				X			X			X	X
Extreme Temperature											X
Wildfire											X
Flood							X			X	X
Hailstorm/ Thunderstorm/ Windstorm				X	X		X			X	X
Landslide / Subsidence					X						X
Tornado				X						X	X
Winter Storm/ Ice					X					X	X
Dam Failure					X		X				X
Hazardous Materials				X							

As a method of better identifying the potential relationships between hazards, the community exhibits can be referenced to indicate the proximity of one or more known hazard areas such as the delineated floodplains and the locations of EHS facilities. For this reason, many of the communities in Brown County may be impacted by more than one hazard at a time, depending on certain conditions. It can be anticipated that if a flood were to occur within these areas, there would be a potentially increased risk of a facility experiencing a hazardous materials incident. These areas may also be at a greater risk of a dam failure.

Future development in areas where multiple known hazard areas (dam failure inundation areas, floodplains and surrounding hazardous materials facilities) overlap should undergo careful design, review, and construction protocol to reduce the risk of social, physical, and economic losses due to a hazard incident. While it may certainly be difficult, critical infrastructure should not be constructed within these regions.

CHAPTER 4: MITIGATION GOALS AND PRACTICES

This section identifies the overall goal for the development and implementation of the Brown County MHMP. A summary of existing and proposed mitigation practices discussed by the Committee is also provided.

4.1 MITIGATION GOAL

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

The Committee reviewed the mitigation goals as outlined within the 2016 Brown County MHMP and determined that each of these remain valid and effective. In summary, the overall goal of the Brown County MHMP is to reduce the social, physical, and economic losses associated with hazard incidents through emergency services, natural resource protection, prevention, property protection, public information, and structural control mitigation practices.

4.2 MITIGATION PRACTICES

REQUIREMENT §201.6(c)(3)(ii):
[The mitigation strategy shall include a] section that identifies and analyzed a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

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

In 2005, the Multi-Hazard Mitigation Council conducted a study about the benefits of hazard mitigation. This study examined grants over a 10-year period (1993-2003) aimed at reducing future damages from earthquake, wind, and flood. It found that mitigation efforts were cost-effective at reducing future losses; resulted in significant benefits to society; and represented significant potential savings to the federal treasury in terms of reduced hazard-related expenditures. This study found that every $1 spent on mitigation efforts resulted in an average of $4 savings for the community. The study also found that FEMA mitigation grants are cost-effective since they often lead to additional non-federally funded mitigation activities and have the greatest benefits in communities that have institutionalized hazard mitigation programs.

A more recent (2017) study by the National Institute of Building Sciences, reviewed over 20 years of federally funded mitigation grants, not only from FEMA but also from the US Economic Development Administration (EDA) and the US Department of Housing and Urban Development (HUD). From this broadened review, it has been determined that for every $1 spent on mitigation, $6 are saved on disaster costs. In addition, by designing and construction buildings which exceed select items in the 2015 International Code, $4 can be saved for every $1 invested in those changes.

Six primary mitigation practices defined by FEMA are:

- **Emergency Services** – measures that protect people during and after a hazard.
- **Natural Resource Protection** – opportunities to preserve and restore natural areas and their function to reduce the impact of hazards.
- **Prevention** – measures that are designed to keep the problem from occurring or getting worse.
- **Property Protection** – measures that are used to modify buildings subject to hazard damage rather than to keep the hazard away.
- **Public Information** – those activities that advise property owners, potential property owners, and visitors about the hazards, ways to protect themselves and their property from the hazards.
- **Structural Control** – physical measures used to prevent hazards from reaching a property.

4.2.1 Existing Mitigation Practices

As part of this planning effort, the Committee discussed the strengths and weaknesses of existing mitigation practices and made recommendations for improvements, as well as suggested new practices. The following is a summary of existing hazard mitigation practices within Brown County. Mitigation measures that were included in the 2016 Brown County MHMP are noted as such.

Emergency Services

- The County has developed a centralized system for mass notification of hazards (Everbridge).
- Stream gages are utilized for flood forecasting and flood warnings for various streams. *(2016 Measure)*
- An IEAP has been developed for all high hazard dams and are routinely reviewed except, for the Reverend Frame and Magness Lake#1 dams. (*2016 Measure)*
- Training and table-top exercises are conducted by the LEPC and include response agencies such as police, fire, and local EMS agencies.
- The Sheriff Department has mobile data terminals and necessary software utilized by the vehicle fleet and dispatchers. *(2016 Measure).*
- The Brown County Community Organizations Active in Disaster (COAD) has been organized and is prepared to support emergency response and sheltering needs in the county.
- A new Emergency Operations Center has been established through which personnel can coordinate response efforts during a hazardous event *(2016 Measure)*
- Brown County municipalities work with event coordinators for several large gathering events in Brown County to assist with emergency response and preparations *(2016 Measure)*
- Brown County has established two American Recross Shelters with power backup capabilities *(2016 Measure)*

Natural Resource Protection

- Brown County and Nashville are in good standing with the NFIP Program and have flood protection ordinances which meets the minimum requirements.
- Current facility maps and response plans are on file for all Tier II HazMat facilities

Prevention

- Brown County utilizes GIS data collection and maintenance which may be used independently and collectively in land use planning decisions and can be utilized in HAZUS-MH "what-if" scenarios. *(2016 Measure)*
- The Brown County LEPC provides training regarding the proper storage, transport, and disposal of hazardous materials.

- Information related to natural hazards has been incorporated into plans and guidance materials to better guide future growth and development (*2016 Measure)*

Property Protection

- Recommendations from completed flood protections studies are implemented as funding becomes available
- Drainage system maintenance, including repair and replacement culverts occurs routinely throughout the county.

Public Information

- Outreach materials and hazard preparedness materials are routinely provided within offices and agencies throughout Brown County, large public events, speaking opportunities within schools, etc. Some of these materials are provided through social media outlets and agency websites; and used during Severe Weather Awareness Week (and others) to raise awareness *(2016 Measure)*
- Brown County EMA provides weather radios to interested businesses and residents as available *(2016 Measure)*
- The EMA and response agencies utilize websites and social media to convey messages to the public prior to, during and following hazardous events. This includes easy to understand information and easy to follow directions.

Structural Control

- Stormwater conveyances are maintained to prevent localized flooding, increased erosion, and material deposition as a result of rainfall or snowmelt.

4.2.2 Proposed Mitigation Practices

After reviewing existing mitigation practices, the Committee reviewed mitigation ideas for each of the hazards studied and identified which of these they felt best met their needs as a community according to selected social, technical, administrative, political, and legal criteria. The following identifies the key considerations for each evaluation criteria:

- **Social** – mitigation projects will have community acceptance, they are compatible with present and future community values, and do not adversely affect one segment of the population.
- **Technical** – mitigation projects will be technically feasible, reduce losses in the long-term, and will not create more problems than they solve.
- **Administrative** – mitigation projects may require additional staff time, alternative sources of funding, and have some maintenance requirements.
- **Political** – mitigation projects will have political and public support.
- **Legal** – mitigation projects will be implemented through the laws, ordinances, and resolutions that are in place.
- **Economic** – mitigation projects can be funded in current or upcoming budget cycles.
- **Environmental** – mitigation projects may have negative consequences on environmental assets such as wetlands, threatened or endangered species, or other protected natural resources.

Table lists a summary of all proposed mitigation practices identified for all hazards, as well as information on the local status, local priority, benefit-cost ratio, project location, responsible entities, and potential funding sources, associated with each proposed practice. The proposed mitigation practices are listed in order of importance to Brown County for implementation. Projects identified by the Committee to be of "high" local priority may be implemented within five years from final Plan adoption. Projects identified to be of "moderate" local priority may be implemented within 5-10 years from final Plan adoption, and projects identified by the Committee to be of "low" local priority may be implemented within 10+ years from final Plan adoptions. However, depending on availability of funding, some proposed mitigation projects may take longer to implement.

As part of the process to identify potential mitigation projects, the Planning Committee weighed the benefit derived from each mitigation practice against the estimated cost of that practice. This basic benefit-cost ratio was based on experience and professional judgement and was utilized to identify the mitigation practices as having a high, moderate, or low benefit-cost ratio. Preparing detailed benefit-cost ratios was beyond the scope of this planning effort and the intent of the MHMP.

The update of this MHMP is a necessary step of a multi-step process to implement programs, policies, and projects to mitigate the effect of hazards in Brown County. The intent of this planning effort was to identify the hazards and the extent to which they affect Brown County and to determine what type of mitigation strategies or practices may be undertaken to mitigate for these hazards. A FEMA-approved MHMP is required to apply for and/or receive project grants under the BRIC, HMGP, and FMA. Although this MHMP meets the requirements of DMA 2000 and eligibility requirements of these grant programs additional detailed studies may need to be completed prior to applying for these grants. **Section 5.0** of this plan includes an implementation plan for all high priority mitigation practices identified by the Committee.

The CRS program credits NFIP communities a maximum of 97 points for setting goals to reduce the impact of flooding and other known natural hazards; identifying mitigation projects that include activities for prevention, property protection, natural resource protection, emergency services, structural control projects, and public information.

Table 30: Proposed Mitigation Measures

Mitigation Practice	Mitigation Strategy	Hazard Addressed	Status	Priority	Benefit-Cost Ratio	Responsible Entity	Funding Source
Emergency Preparedness & Warning 1. Utilize a hazard broadcast system, Everbridge, to distribute mass notifications to residents and visitors through telephones, text, and email announcements. Consider second language notification (Spanish). *(2016 Measure)* 2. Evaluate flood forecasting capabilities including stream gages, flood forecast maps, and flood alerts *(2016 Measure)* 3. Evaluate outdoor warning siren locations and coverage. Complete software upgrades and relocation (if determined necessary) to alert populations of severe weather conditions *(2016 Measure)* 4. Purchase and utilize message boards during hazard events *(2016 Measure)* 5. Improve disaster preparedness and emergency response at the local level through use of the Community Emergency Response Team (CERT) program or similar programs such as COAD. 6. Develop a plan for testing, maintenance, and operation of the outdoor warning sirens.	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Fire ☒ Flood ☒ Hail/Thunder/Wind ☒ Landslide/Subsidence ☒ Tornado ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** 1. Continue to utilize the Everbridge system to notify community members of hazards within the community 2. The county has one real-time AHPS stream gage (North Fork Salt Creek at Nashville) 3. Sirens provide coverage for most populated areas 4. Two message boards are being used, one is housed at Sweetwater and the other at the EMA offices 5. Have an active COAD to support Emergency Management during incidents and disaster events. **Proposed Enhancements –** 1. Increase enrollment and maintain the Everbridge program 2. Research the need for additional gages upstream to provide advanced warning. (*Possibly Gatesville area – confluence of 3 creeks – East Fork Salt Creek, North Fork Salt Creek and Sweetwater Creek)* 3. Improve coverage of outdoor warning sirens 4. Acquire one additional message board for use by County Highway Dept. 5. Recruit team members and offer specialized training, such as wildland EMS skills and wilderness training. 6. Develop a plan for testing, maintenance, and operation of the outdoor warning sirens.	High *(stream gages, siren plan)* Moderate *(mass notifications, siren coverage, message, COAD*	High	EMA USGS Message Board Owners CERT and/or COAD Trainers and Specialty skills trainers.	Existing Budgets Grants
Building Protection 1. Enforce zoning laws and restrict the development of new critical infrastructure in 1% & 0.2% AEP. 2. Educate Government representatives on the importance of floodplain management procedures and permitting restrictions. 3. Protect existing critical facilities in the floodplain. 4. Develop a floodplain/FEH overlay district to further protect area from development while allowing passive uses. 5. Relocate, buy out or floodproof non-residential structures subject to repetitive flooding. *(Will assist with NFIP compliance)*	☒ Emergency Services ☒ Nat. Res. Protection ☐ Prevention ☒ Property Protection ☐ Public Information ☒ Structural Control	☐ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Fire ☒ Flood ☒ Hail/Thunder/Wind ☒ Landslide/Subsidence ☒ Tornado ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** 3. Ordinances discourage construction of new critical facilities in 1% AEP flood area **Proposed Enhancements –** 1. Prohibit development in floodplains and include 0.2% AEP. 2. Educate Government representatives on the importance of floodplain management procedures and permitting restrictions. 3. Protect and consider future relocation of the wastewater treatment plant (WWTP) (Boston and Jefferson St. to W. Washington St.) 4. Develop a floodplain/FEH overlay district. 5. Relocate, buy out or floodproof non-residential structures subject to repetitive flooding	High *(Educate Government Officials, WWTP protection/relocation)* Moderate *(Prohibit development in the floodplain, Develop floodplain overlays)* Low *(Relocate/buy-out structures)*	High	EMA Facility Owners Floodplain Administrator Brown County Commissioners Building Departments	Grant Existing Budget Municipal bonds Revolving Loans

Mitigation Practice	Mitigation Strategy	Hazard Addressed	Status	Priority	Benefit-Cost Ratio	Responsible Entity	Funding Source
Emergency Response & Recovery 1. Inventory and prioritize needs for mobile data terminals, including hardware and software, to be placed in appropriate response vehicles 2. Investigate most efficient and protected method to back up county and municipal records 3. Maintain a database of accurate and community specific information following each hazard event including extent, magnitude, cost, response and recovery efforts. *(2016 Measure)* 4. Annually review and update as necessary the Nashville Flood Response Plan (FRP) to improve response and reduce losses from a flood event 5. Acquire satellite phones for emergency communications within the county. *(2016 Measure)* 6. Establish procedures to evacuate the population in known hazard areas. 7. Establish an ice and water rescue team 8. Enhance Emergency Operations Center (EOC) Security including Health Department and other disaster coordination sites. 9. Develop and implement a sandbagging plan. Explore the purchase of a sandbagging machine	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☐ Property Protection ☒ Public Information ☐ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Fire ☒ Flood ☒ Hail/Thunder/Wind ☒ Landslide/Subsidence ☒ Tornado ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** 1. Some response agencies and vehicles currently have equipment (Sheriff and EMS) 2. Digital records are being backed up in the cloud. **Proposed Enhancement –** 1. Work with agency liaison to inventory needs for each response agency and prioritize on a countywide basis 2. Establish consistent protocols for hard copy document storage and records back up throughout the county 3. Create a more consistent reporting and documentation effort following hazard events. Identify a source for database development 4. Develop team to review and update the existing FRP. Create a countywide FRP and include dam inundation. 5. Acquire a limited number of satellite phones for redundancy 6. Identify routes and procedures for evacuation beginning with one small item/event and then build on the small success 7. Identify possible sources of funding for team formation and sustainment. 8. Add card reader system to unsecured doorways at the EOC and other unsecure locations serving as disaster coordination sites. 9. Purchase a sandbagging machine. Develop a plan for sandbagging efforts and implement	High *(Enhance security/card readers, sandbagging, FRP)* Moderate *(mobile data terminals, post event document, database, evacuation routes, rescue,)* Low *(satellite phones)*	High	EMA Community Contacts *County, Nashville* Brown County Sheriff Fire Departments Police Department Brown County IT Department Brown County Health Department	Existing Budget Grants
Flood Studies and Protection 1. Conduct detailed flood studies for problem areas (such as stream crossing and culverts) and/or areas with repetitive flooding problems *(2016 Measure)* 2. Prioritize areas for preventative debris removal in streams especially near culverts and bridges, to prevent flooding, ice jams, and damage to bridges and culverts. 3. Upgrade stormwater drainage system – current system drains to the WWTP. 4. Mitigate erosion near roadways 5. Inventory and prioritize areas in need of bridge and culvert repair and/or expansion to improve local drainage *(Will assist with NFIP compliance)*	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Fire ☒ Flood ☐ Hail/Thunder/Wind ☐ Landslide/Subsidence ☐ Tornado ☐ Winter Storm/Ice ☐ Dam Failure ☐ HazMat Incident	**Ongoing –** 1. Studies are completed as funding becomes available 5. Some work has been completed on an inventory of bridges and culverts. **Proposed Enhancements –** 1. Develop prioritized listing of needed studies and continue to complete as funding becomes available 2. Update priority list of streams where debris is collecting and, where necessary, remove debris from priority locations. 3. Determine best solutions for an upgrade to the stormwater drainage system 4. Mitigate erosion near roadways especially along SR 46 near Kelp Grove Rd and Green Valley Rd and other locations as identified. Continue to complete as funding becomes available 5. Complete inventory and prioritization of bridges and culverts in need of repair or expansion to enhance local drainage.	High *(all 5 items are High priority)*	Moderate	EMA Floodplain Administrators *County, Nashville* Planning Departments *County, Nashville* Brown County Surveyor Brown County Highway	Existing Budget Grants Infrastructure Funds Municipal Bonds

Mitigation Practice	Mitigation Strategy	Hazard Addressed	Status	Priority	Benefit-Cost Ratio	Responsible Entity	Funding Source
Land Use Planning and Zoning 1. Incorporate hazard information, and risk assessment into the Comprehensive Land Use Plan to better guide future growth and development *(2016 Measure)*	☐ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Fire ☒ Flood ☐ Hail/Thunder/Wind ☒ Landslide/Subsidence ☐ Tornado ☐ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** **Proposed Enhancements –** 1. Increase the number of hazards considered(include FEH and Dams along with others as needed), to more definitively outline higher risk areas and those that should be avoided for future development.	High	Moderate	EMA Floodplain Administrators *County, Nashville* Planning Departments *County, Nashville* Brown County Commissioners	Existing Budget Grant
Community Rating System 1. Investigate potential to reduce flood insurance premiums through additional participation in the NFIP's CRS Program. *(2016 Measure)* *(Will assist with NFIP compliance)*	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Fire ☒ Flood ☐ Hail/Thunder/Wind ☐ Landslide/Subsidence ☐ Tornado ☐ Winter Storm/Ice ☐ Dam Failure ☐ HazMat Incident	**Ongoing –** **Proposed Enhancement –** 1. Encourage CRS participation by the Nashville and Brown County floodplain administrators.	Moderate	Moderate	Floodplain Administrators *County, Nashville*	Existing Budget
Geographic Information Systems 1. Train GIS staff in HAZUS-MH to quantitatively estimate losses in "what if scenarios" and continue to use the most recent GIS data in land use planning efforts *(2016 Measure)*	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☐ Public Information ☒ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Fire ☒ Flood ☒ Hail/Thunder/Wind ☒ Landslide/Subsidence ☒ Tornado ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** 1. GIS layers have been developed and are utilized by some departments **Proposed Enhancements –** 1. Provide training opportunities for GIS staff related to HAZUS-MH and continue to keep critical facilities information up to date	Moderate	Moderate	GIS Department *County (covers Nashville)*	Existing Budget Grant
Management of Dams 1. Review regular inspection and maintenance records of high hazard dams 2. Encourage high hazard dam owners to develop an IEAP.	☒ Emergency Services ☐ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☐ Public Information ☒ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Fire ☐ Flood ☐ Hail/Thunder/Wind ☐ Landslide/Subsidence ☐ Tornado ☐ Winter Storm/Ice ☒ Dam Failure ☐ HazMat Incident	**Ongoing –** 1. Reviewing inspection reports when received by EMA **Proposed Enhancements –** 1. Contact high hazard dam owners to review inspection and maintenance records for high hazard dams 2. Contact high hazard dam owners to encourage them to develop an IEAP (Mangness#1 and Reverend Frame Dams)	High *(IEAPs)* Moderate *(inspections)*	Low	High Hazard Dam Owners IDNR EMA	Existing Budget Grant

Mitigation Practice	Mitigation Strategy	Hazard Addressed	Status	Priority	Benefit-Cost Ratio	Responsible Entity	Funding Source
Power Backup Generators 1. Inventory, prioritize, and retrofit public facilities with appropriate wiring and electrical capabilities or transfer switches to enable the utilization of large power backup generators. 2. Secure a fuel reserve, or ensure contractual emergency provisions so critical infrastructure may run on power backup for extended periods of time 3. Require power backup generators in all critical facilities. (new and existing facilities) 4. Designate fuel reserve transportation routes.	☒ Emergency Services ☐ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☐ Public Information ☐ Structural Control	☐ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Fire ☒ Flood ☒ Hail/Thunder/Wind ☒ Landslide/Subsidence ☒ Tornado ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** 1. Many critical facilities have generators or have added since the last plan – (*All fire depts., courthouse, jail and YMCA. Health Dept. is in the process now.)* **Proposed Enhancements –** *1.* Inventory generator capabilities and needs and prioritize within each community to determine needs for future purchases – (*Highway Dept.)* 2. Secure fuel reserves via contract service agreements 3. Draft an ordinance and secure adoption. 4. Designate routes to access fuel reserves.	High *(all 4 items are High priority)*	Low	EMA County Commissioners Town Council *Nashville* Facility Owners Fuel Providers	Existing Budget Grants
Safer Rooms and Community Shelters 1. Construct safe rooms or designated shelters for schools in Brown County 2. Clearly advertise the location of safe rooms and community shelters for large gatherings of people (football games, 4 H fair, etc.) 3. Create large events plans for emergency actions during hazardous events. 4. Develop temporary and/or long-term shelter agreements within the County. Examine the potential for a tiered approach to sheltering people, pets, etc.	☒ Emergency Services ☐ Nat. Res. Protection ☐ Prevention ☐ Property Protection ☒ Public Information ☒ Structural Control	☐ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Flood ☒ Hail/Thunder/Wind ☐ Landslide/Subsidence ☒ Tornado ☒ Wildfire ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** *4.* Some shelter agreements are in place through Red Cross and EMA. *(2 churches, all schools and YMCA)* **Proposed Enhancement –** 1. Construct additional safe rooms or designated shelters for schools in Brown County. 2. Clearly advertise the location of currently available safe rooms and community shelters for large gatherings 3. Create an emergency action plan for one event such as the fair to develop a model, then expand to other events. Include who is watching weather, etc. **4.** Add music center to the list of shelters. Consider camps for remote locations, if needed.	High *(all 4 items are High priority)*	Low	EMA COAD Red Cross	Existing budget Facility owners Event planners
Hazardous Materials 1. Require warning at each intersection between rail and road to reduce potential for train/vehicular accidents. 2. Complete transportation survey (Haz Mat Commodity Flow Study) to determine typical chemicals and quantities of chemicals being transported throughout Brown County. 3. Establish and maintain a local HazMat Response Team. 4. Inventory of HazMat resources and Fire Department Equipment.	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Flood ☐ Hail/Thunder/Wind ☐ Landslide/Subsidence ☐ Tornado ☐ Wildfire ☐ Winter Storm/Ice ☐ Dam Failure ☒ HazMat Incident	**Ongoing –** **Proposed Enhancement –** 1. Require warning at each intersection between rail and road to reduce potential for train/vehicular accidents. 2. Complete transportation survey (Haz Mat Commodity Flow Study). Establish a means to be better informed about the materials being transported to the military facilities. 3. Establish and maintain a local HazMat Response capacity that will work for the County. 4. Inventory HazMat resources and Fire Department equipment. Create a database to record all resources and identify needs.	**Low** *(all items are Low priority)*	**Low**	Fire Departments Health Department EMA Contractors	Railroads HMEP grant Township Trustees Local Business and Industry

Mitigation Practice	Mitigation Strategy	Hazard Addressed	Status	Priority	Benefit-Cost Ratio	Responsible Entity	Funding Source
Water Conservation 1) Establish and adopt local water conservation ordinance and contingency plans to impose at the time of water shortages	☒ Emergency Services ☐ Nat. Res. Protection ☐ Prevention ☐ Property Protection ☒ Public Information ☒ Structural Control	☒ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Flood ☐ Hail/Thunder/Wind ☐ Landslide/Subsidence ☐ Tornado ☐ Wildfire ☐ Winter Storm/Ice ☐ Dam Failure ☐ HazMat Incident	**Ongoing –** **Proposed Enhancement –** 1) Work with water utilities to develop contingency plans and ordinance language for presentation and adoption by County Commissioners.	High	Low	EMA Water Utilities Commissioners	Utilities Nashville Town Board and/or County Commissioners
Public Education and Outreach 1) Provide hazard preparedness (warning sirens, radio stations, go kits, insurance protection, etc.) literature at public facilities, events, parks, etc. 2) Partner with local volunteer groups and watershed organizations to make community members aware of ongoing beneficial actions and future plans.	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Flood ☒ Hail/Thunder/Wind ☒ Landslide/Subsidence ☒ Tornado ☒ Wildfire ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** 1) Continue to provide hazard preparedness literature and materials during events, at parks and public facilities. 2) Continue to work with the COAD, Lake Monroe watershed district, the sanitary district and others to make community members and leadership aware of ongoing beneficial actions and potential opportunities. **Proposed Enhancement –**	Low *(all are Low priority)*	Low	EMA All Fire Departments throughout the County Health Department COAD	Mitigation grants COAD Health Dept.

CHAPTER 5: IMPLEMENTATION PLAN

The following is a proposed plan for implementing all high priority mitigation practices identified in this Plan. It should be noted that implementation of each of these proposed practices may involve several preparatory or intermediary steps. However, to maintain clarity, not all preparatory or intermediary steps are included.

5.1 EMERGENCY PREPAREDNESS AND WARNING

Research the need for additional gages upstream to provide advanced warning.

- Review and evaluate existing flood forecasting capabilities and determine areas of need for increased warning time and flood alerts
- Prioritize areas needing gages and determine options for gage placement upstream of the current stream gage. Consider possibly the Gatesville area at the confluence of 3 streams - East Fork Salt Creek, North Fork Salt Creek and Sweetwater Creek.
- Secure funding and implement recommendations of the study team.
- Upon installation, provide updated location information and alert links to appropriate response agencies

Improve coverage of outdoor warning sirens.

- Review current siren locations and actual coverage taking into consideration terrain, and structures that might deflect or limit coverage. Review operational practices to determine if there are any ways to enhance coverage from the current locations.
- If a need for additional coverage is identified, determine best mechanism to address that coverage issue. (Additional siren, relocation of an existing siren, alternatives to outdoor warning sirens)
- Examine current activation and utilization processes and procedures – both documented and undocumented.
- Write up operational protocols and develop plan which includes testing, operation and maintenance, but also provisions and process for plan review and update.
- Secure buy-in from all parties, finalize and publish plan. Frequently verify its use and where clarifications may be needed.

5.2 BUILDING PROTECTION

Educate Government representatives on the importance of floodplain management procedures and permitting restrictions.

- Identify, and share with community leaders, sources of good floodplain educational materials to help government representatives better understand the issues associated with floodplains.
- Meet with leaders to discuss floodplain management procedures and permitting restrictions. Possibly invite NFIP staff from state to help clarify any questions regarding permitting restrictions and potential ways for communities to address challenges that may arise.

Protect and consider future relocation of the wastewater treatment plant.

- Identify and evaluate feasible methods to protect the current wastewater treatment plant for the next 5-7 years. (examples could be floodproofing, physical barriers, utility elevation, etc.)
- Prepare plans for protective actions and identify costs. Identify funding sources and appropriate funding for implementation of the protective actions.
- Identify future locations for wastewater treatment plant relocation. Identify financial needs for relocation.
- Prepare a muti-year action plan for the relocation of the wastewater treatment plant.

5.3 EMERGENCY RESPONSE AND RECOVERY

Develop team to review and update the existing FRP. Create a countywide FRP and include dam inundation.

- Secure funding and support to update existing Town of Nashville FRP and create a countywide version for implementation by the County.
- Review existing Town of Nashville FRP and determine where updates are needed. Also determine what challenges exist that have prevented the full utilization of the existing FRP.
- Make updates to existing Town FRP to reflect their capabilities, challenges and needs.
- Using Town FRP, assemble Countywide version which identifies county risks, hazards, capabilities and opportunities for full community resilience.

Add card reader system to unsecured doorways at the EOC and other unsecure locations serving as disaster coordination sites.

- Inventory EOC, alternate EOC, and disaster coordination site accessways, identifying locations which are presently not secured.
- Research sources for providing access and security card readers at the identified locations.
- Secure funding for the purchase and installation of the equipment and provide for maintenance and repairs for the system.

Purchase a sandbagging machine and develop a plan for sandbagging efforts. Implement the new plan.

- Identify the best suited sandbagging machine for the County and secure funding to purchase the machine.
- Review existing sandbagging protocols and procedures. Develop an action plan for sandbagging activities – assure plan includes both mechanized and manual methods should mechanized equipment not be available.
- Distribute the plan and exercise with organizations that may utilize the plan in the future. Include volunteer organizations to assure familiarity with the plan.

5.4 FLOOD STUDIES AND PROTECTION

Develop prioritized listing of needed studies and continue to complete as funding becomes available.

- Compile a listing of completed flood studies and list studies needed for the communities and county.
- Prioritize the studies based on risk and identify potential funding sources.
- As matching funds and assistance is available, complete studies and review considering other studies already completed.

Update priority list of streams where debris is collecting and, where necessary, remove debris from priority locations.

- Identify and prioritize locations where debris is collected and potentially damaging or has the potential to damage critical infrastructure such as bridges and culverts. County highway and street department may have some information to assist with this listing.
- Secure cost estimates and funding, municipal bonds, or funds from existing budgets to complete the debris removal.
- Procure contract assistance as necessary. Secure required permits for debris removal.
- Complete and document the removal activities, reassess priorities and continue program as funds become available.

Determine best solutions for an upgrade to the stormwater drainage system

- Review data and identify the primary sources of stormwater entering the Wastewater Treatment Plant. (May require specialized water source tracing to determine source locations)
- Secure funding, municipal bond, or funds from existing budgets to complete studies and identify potential solutions.
- Implement selected solution, documenting costs as well as cost savings from implementation of the mitigation actions.

Mitigate erosion near roadways especially along SR 46 near Kelp Grove Rd and Green Valley Road and other locations as identified. Continue to complete as funding becomes available.

- Study causes of erosion and identify the most viable long-term solutions to address the erosion.
- Secure funding, municipal bond, or funds from existing budgets to complete watershed, FEH, and impact studies. Secure funding to implement the chosen solution
- Implement actions and document impacts of the solution.

Complete inventory and prioritization of bridges and culverts in need of repair or expansion to enhance local drainage.

- Using the county highway bridge and culvert inventory, identify structures in need of repair or enlargement. Prioritize structures based on frequency of damage, impact upon local populations and costs to maintain structures if not fully repaired/replaced or expanded.
- Identify any impacts that may result from increased water flow when repairs/or expansions are implemented.
- Secure funding from current budgets, local bonds, grants, etc. for the repair, replacement, or expansion of priority structures.
- Implement solutions, reassess priorities and continue actions as funds are available.

5.5 LAND USE PLANNING AND ZONING

Increase the number of hazards considered (include FEH and Dams along with others as needed), to outline higher risk areas more definitively and those that should be avoided for future development.

- Educate land use planners and community leaders about the hazards and risks associated with FEH and Dams in Brown County.
- Provide model language from other counties to assist with the incorporation of the new standards in the comprehensive land use plans.
- Provide links to digital tools for area delineation and further education.

5.6 MANAGEMENT OF DAMS

Contact high hazard dam owners to encourage them to develop an IEAP (Mangness#1 and Reverend Frame Dams)

- Contact dam owners and explain the new state law that requires high hazard dams to have an IEAP for their dam structure.
- Assist dam owner in locating support services, if necessary, to write plan and exercises to test the plan for future uses.
- Regularly follow up with dam owners on plan creation and updates.

5.7 POWER BACKUP GENERATORS

Inventory generator capabilities and needs and prioritize within each community facility to determine needs for future purchases

- Identify critical infrastructure and shelters, completing a survey with generator capabilities and potential needs. (Highway and IT have known needs, but unsure of any other infrastructure or shelters)
- Prioritized needs based upon critical and essential services provided by the facilities.
- Support the acquisition and installation of generators, switches, etc. to meet all the needs of the facility should long-term power generation be necessary. Recommend potential funding mechanisms.

Secure fuel reserves via contract service agreements

- Identify the source(s) of fuel reserves for generators.
- Secure emergency services through contracts, Memorandums of Understanding (MOUs), etc.
- Assure agreements are regularly updated and renewed, especially after a large event where services were needed.

Draft and adopt an ordinance to require all new critical facilities have backup power and phase in process for existing critical facilities

- Educate government leadership on the need for power backup generators at critical facilities.
- Working with county legal staff draft ordinance requiring power backup generators for all new critical facilities and a phase in period for existing facilities.
- Implement the ordinance and document utilization of capacity during disaster events.

Designate routes to access fuel reserves.

- Upon establishing agreements for fuel reserves, identify secured routes to access the fuel reserves.
- Set up a protocol with law enforcement, county highway department, first responders, etc. to help in securing these routes to assure unhampered movement of fuel supplies to keep critical facilities functioning.

5.8 SAFER ROOMS AND COMMUNITY SHELTERS

Construct new safe rooms or designated shelters for schools in Brown County.

- Identify current shelters at each of the schools where people may seek shelter during severe weather events. Considerations when identifying spaces are proximity to the large group gathering and handicapped accessible. Clearly mark the areas serving as shelters.
- Consider and identify schools that would benefit from the installation/construction of safe rooms for both occupants of the school and/or community members.
- Incorporate into school construction/modification plans the incorporation of safe room space for the facility.
- Research and secure funding assistance for construction of safe room(s).

Clearly advertise the location of currently available safe rooms and community shelters for large gatherings.

- Research best practices for universal signage creation. Consider font size, color, icons/symbols, etc.
- Create universal signage identifying the locations of shelters for large group gatherings.
- Place universal signage in prominent locations directing people to shelter spaces.

Create an emergency action plan for one event such as the fair to develop a template, then expand to other events. Include who is watching weather, etc.

- Assemble an emergency action plan writing team including event promoter(s)/owner(s), EMA, public safety, etc.
- Assure the Emergency Action Plan incorporates the Risk Assessment from the MHMP identifying and documenting the impacts of each hazard/risk upon the event, assessing the impacted populations at the event, actions needed by the event hosts and first responders to assure safety, preparatory actions (such as weather monitoring, communications, chain of command, etc.) etc.
- During plan preparation identify if-then scenarios and what actions will be taken by which organization to address that particular challenge.

Add music center to the list of shelters. Consider camps for remote locations, if needed.

- Review list of County and Red Cross shelters.
- Meet with owners and managers of the music center to secure agreement to serve as a shelter and any situations that would preclude the center from serving as a shelter.
- Complete Memorandums Of Understanding (MOU) or Memorandums Of Agreement (MOA), as needed.
- Examine the location of various camp facilities and determine if they would be useful as local shelters for localized events, or onsite populations, only.
- Discuss sheltering needs and concepts with camp owners/operators and determine their level of participation in the overall scheme of the County Sheltering Plan.

5.9 WATER CONSERVATION

Establish and adopt local water conservation ordinance and contingency plans to impose at the time of water shortages. Work with water utilities to develop contingency plans and ordinance language for presentation and adoption by County Commissioners.

- Review existing water usage plans with government leadership, the water utilities, and planning team.
- Identify trigger points when each entity identifies a water emergency which may result in a call for water conservation. (for fire departments wildfire may be the trigger whereas for Water Utility it may be reservoir height, etc.)
- Research water conservation ordinances within Indiana and determine how the ordinances are implemented, etc. Use examples to draft county ordinance to assure it meets the needs of the county and its communities.
- Present draft ordinance to commissioners after providing educational materials on the needs and benefits for such an ordinance.

CHAPTER 6: PLAN MAINTENANCE PROCESS

6.1 MONITORING, EVALUATING, AND UPDATING THE PLAN

REQUIREMENT §201.6(c)(4)(i):
[The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

To effectively reduce social, physical, and economic losses in Brown County, it is important that implementation of this MHMP be monitored, evaluated, and updated. The EMA Director is ultimately responsible for the MHMP. As illustrated in Section 4.2 Mitigation Practices, this Plan contains mitigation program, projects, and policies from multiple departments within each incorporated community. Depending on grant opportunities and fiscal resources, mitigation practices may be implemented independently, by individual communities, or through local partnerships. Therefore, the successful implementation of this MHMP will require the participation and cooperation of the entire Committee to successfully monitor, evaluate, and update the Brown County MHMP.

The EMA Director will reconvene the MHMP Committee on an annual basis and following a significant hazard incident to determine whether:

- the nature, magnitude, and/or type of risk have changed
- the current resources are appropriate for implementation
- there are implementation problems, such as technical, political, legal, or coordination issues with other agencies
- the outcomes have occurred as expected
- the agencies and other partners participated as originally proposed

During the annual meetings the Implementation Checklist provided in **Appendix 10** will be helpful to track any progress, successes, and problems experienced.

The data used to prepare this MHMP was based on "best available data" or data that was readily available during the development of this Plan. Because of this, there are limitations to the data. As more accurate data becomes available, updates should be made to the list of critical infrastructure, the risk assessment, and vulnerability analysis.

DMA 2000 requires local jurisdictions to update and resubmit their MHMP within five years (from the date of FEMA approval) to continue to be eligible for mitigation project grant funding. In early 2027, the EMA Director will once again reconvene the MHMP Committee for a series of meetings designed to replicate the original planning process. Information gathered following individual hazard incidents and annual meetings will be utilized along with updated vulnerability assessments to assess the risks associated with each hazard common in Brown County. These hazards, and associated mitigation goals and practices will be prioritized and detailed as in Section 3.0 this MHMP. Sections 4.0 and 5.0 will be updated to reflect any practices implemented within the interim as well as any additional practices discussed by the Committee during the update process.

Prior to submission of the updated MHMP, a public meeting will be held to present the information to residents of Brown County and to provide them an opportunity for review and comment of the draft

MHMP. A media release will be issued providing information related to the update, the planning process, and details of the public meeting.

6.2 INCORPORATION INTO EXISTING PLANNING MECHANISMS

REQUIREMENT §201.6(c)(4)(ii):
[The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as the comprehensive or capital improvements, when appropriate.

Many of the mitigation practices identified as part of this planning process are ongoing with some enhancement needed. Where needed, modifications will be proposed for each NFIP communities' planning documents and ordinances during the regularly scheduled update including comprehensive plans, floodplain management plans, zoning ordinances, site development regulations, and permits. Modifications include discussions related to hazardous material facility buffers, floodplain areas, and discouraging development of new critical infrastructure in known hazard areas.

6.3 CONTINUED PUBLIC INVOLVEMENT

REQUIREMENT §201.6(c)(4)(iii):
[The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.

Continued public involvement is critical to the successful implementation of the Brown County MHMP. Comments gathered from the public on the MHMP will be received by the EMA Director and forwarded to the MHMP Committee for discussion. Education efforts for hazard mitigation will be the focus of the annual Severe Weather Awareness Week as well as incorporated into existing stormwater planning, land use planning, and special projects/studies efforts. Once adopted, a copy of this Plan will be available for the public to review in the EMA Office and the Brown County website.

Updates or modifications to the Brown County MHMP will require a public notice and/or meeting prior to submitting revisions to the individual jurisdictions for approval.

The CRS program credits NFIP communities a maximum of 37 points for adopting the Plan; establishing a procedure for implementation, review, and updating the Plan; and submitting an annual evaluation report.

CHAPTER 7: REFERENCES

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