MULTI-HAZARD MITIGATION PLAN UPDATE

Montgomery County, Indiana

Prepared for:

Montgomery County, Indiana
City of Crawfordsville, Indiana
Town of Darlington, Indiana
Town of Waveland, Indiana
Town of Waynetown, Indiana

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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, **Figure 1-1** includes 4 phases:

Figure 1-1 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 Montgomery 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.

1.2 PROJECT SCOPE AND 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.

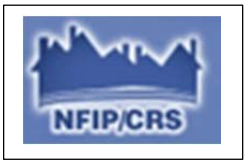
A MHMP is a requirement of the Federal Disaster Mitigation Act of 2000 (DMA 2000). According to DMA 2000, the purpose of mitigation planning is for State, local, and Indian tribal governments to identify the natural hazards that impact them, to identify actions and activities to reduce any losses from 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 in order to apply for and/or receive project grants under the Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM), Flood Mitigation Assistance (FMA), and Severe Repetitive Loss (SRL). FEMA may require a MHMP under the Repetitive Flood Claims (RFC) program. Although the Montgomery 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.

In order 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 5 years. MHMP updates must demonstrate that progress has been made in the last 5 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 Montgomery County MHMP Update is a multi-jurisdictional planning effort led by the Montgomery County Emergency Management Agency (EMA). This Plan was prepared in partnership with Montgomery County, the City of Crawfordsville, the Town of Darlington, the Town of Waveland, and the Town

of Waynetown. 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 communities had an equal opportunity for participation and representation in the planning process, the process used to update the Montgomery 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 3 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 are necessary to enter the CRS program and receive a 5% flood insurance premium discount. This MHMP could contribute as many as 294 points toward participation in the CRS. At the time of this planning effort, none of the Montgomery County communities participate in the CRS program.

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

1.3 PLANNING 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 Montgomery County MHMP Update began in 2013 when the County EMA submitted a PDM Grant application to IDHS. The grant request was approved by FEMA and grant funds were awarded in 2015.

Once the grant was awarded, the planning process to update the 2007 MHMP took 15 months. This included a 10 month planning process, followed by a

review period by IDHS and FEMA for the draft MHMP Update, and another month for Montgomery County, the City of Crawfordsville, the Town of Darlington, the Town of Waveland, and the Town of Waynetown to adopt the final MHMP Update.

1.3.1 Planning Committee and Project Team

In March of 2015, 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 2007. **Table 1-1** lists the individuals that participated on the Committee and the entity they represented.

Table 1-1 MHMP Update Committee

NAME	TITLE	REPRESENTING
Brandy Allen	Dir. Of Planning and Community Development	City of Crawfordsville
Phil	President of County Commissioners	Montgomery County
Todd	Mayor of Crawfordsville	City of Crawfordsville
Marc Bonwell	County Building Commissioner	Montgomery County
Brian Campbell	EMA Deputy Director	Montgomery County
Tom Cummins	County Surveyor	Montgomery County
Mike Norman	Mapping/Emergency addressing	City of Crawfordsville
Caitlin Dorsey		Montgomery County
Lori Dossett	Admin Asst. for County Commissioners	Montgomery County
Dennis	New Market Utilities	
Shari Harrington	EMA Director	
Earl Heide	Linden Utilities	
Scott Hessler	Crawfordsville Street Commissioner	
Rod	County Highway Superintendent	
Larry	Crawfordsville Wastewater	
Roger	New Richmond Utilities	
Troy	Darlington Wastewater	
Roger	Ladoga Utilities	
Paul	Utilities Superintendent	
Gary	Stormwater	
	New Ross Utilities	
Troy	Utilities	

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 2007 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; and reviewed materials for public participation. A sign-in sheet recorded those present at each meeting to document participation. Meeting agendas and summaries are included in **Appendix 2**. *Members of the Committee attended the public meeting in May 2016 and assisted with adoption of the Montgomery County MHMP Update.*

1.3.2 Public Involvement

A draft of the Montgomery County MHMP Update was posted online on the EMA website for public review and comment. Committee members were provided with an informational flyer to display in their respective offices.

A public meeting was held on May x, 2016 in the [where] Members of the Committee were present to describe details of the plan as well as to answer questions presented by attendees. The media release and power point presentation are located in ***Appendix 3****.*

1.3.3 Involvement of Other Interested Parties

Interested agencies, businesses, academia, and nonprofits were invited to review and comment on the draft Montgomery County MHMP Update (Appendix 3). Information related to the planning process, the public meeting, and the availability of the draft Montgomery County MHMP was directly provided to such potentially interested parties via personal conversations, informational flyer, and press releases. Successful implementation and future updates of the Montgomery County MHMP Update will rely on the partnership and coordination of efforts between such groups.

1.4 PLANS, STUDIES, REPORTS, AND TECHNICAL INFORMATION

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

During the development of the Montgomery 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 original Montgomery County MHMP, and to assist the Committee in developing potential mitigation measures to reduce the social, physical, and economic losses associated with hazards affecting Montgomery County.

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

- City of Crawfordsville Indiana Comprehensive Plan 2025
- Montgomery County/Crawfordsville Economic Development Plan
- Montgomery County Comprehensive Emergency Management Plan
- Montgomery County Code: Chapter 37: Emergency Management

The CRS program credits NFIP communities a maximum of 100 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, it is important background information about the physical, social, and economical composition of Montgomery County necessary to better understand the Risk Assessment discussed in **Chapter 3**.

Montgomery County, organized in 1823, is named after Richard Montgomery, an American Revolutionary War general killed in 1775 while attempting to capture Quebec City, Canada in the Battle of Quebec. The total area of Montgomery County is approximately 505 square miles. The location of Montgomery County within the State of Indiana is identified in **Figure 2-1**.

2.1 POPULATION AND DEMOGRAPHICS

Figure 2-1 Montgomery County Location

The most recent data for Montgomery County estimates that the 2014 population was 38,146, which ranks 40th in the State. Of that total, the City of Crawfordsville accounts for 15,988 or 42% of the county's population while the Town of Waynetown is the third largest community with 954 or 2.5% of the population.

In 2014, the median age of the population in the County was 40.3 years of age. The largest demographic age groups in the County are older adults (45-64 years) with a population of 10,452, and young adults (24-44 years) with a population of 8,741. School aged children (5-17) are the third largest age group with a population of 6,501 individuals living in Montgomery County. The approximate median household income in 2013 was reported to be $50,889 while the poverty rate in the same year was reported at 12.5% county-wide. In total, 21.1% of households are married with children, and 35.8% of households are married without children.

Nearly 88% of the adults, older than 25, within the County have reportedly completed a High School education. Further, 17.8% of those same adults have also completed a Bachelor of Arts or higher degree.

2.2 EMPLOYMENT

US Census data indicates that of the Montgomery County work force, 37.1% are employed in manufacturing positions. Government and

Other/Private account for 10.8% and 8.0% respectively. The total resident labor force according to estimates in 2014 is 18,633 with 1,032 unemployed and an unemployment rate of 4.1% or 64th in the State out of 92 counties.

Table 2-1 List of Major Employers

RR Donnelley	Nucor Steel
Acuity Brands Lighting Inc	Franciscan St Elizabeth Health
Indiana Home Care Plus	Walmart Supercenter
Banjo Corp	Closure Systems Intl
Pace Dairy of Indiana	Random House Inc

(Indiana Department of Workforce Development, 2015)

2.3 TRANSPORTATION AND COMMUTIING PATTERNS

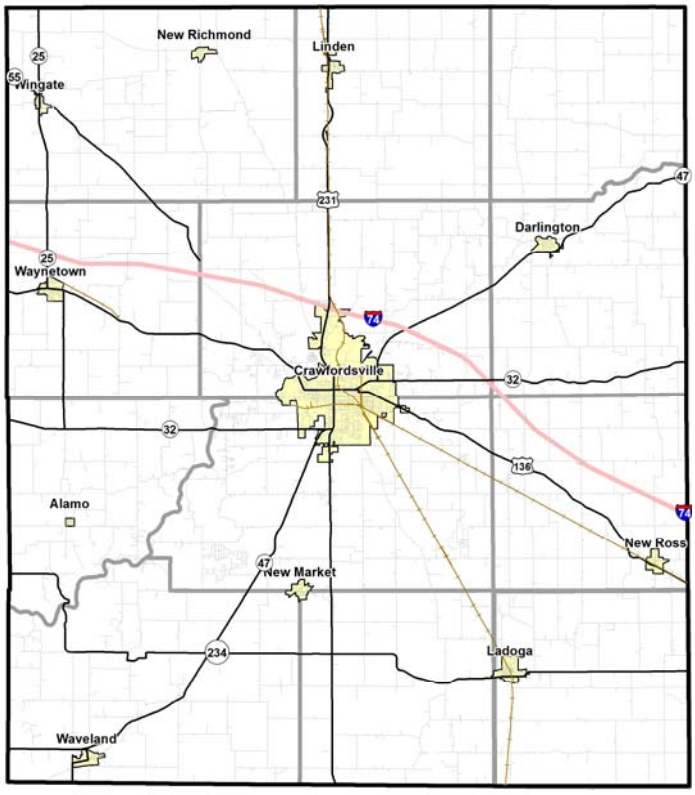


Figure 2-2 Montgomery County Transportation Routes

There are several major transportation routes passing through Montgomery County and the municipalities within. Interstate 74, and State Roads 25, 32, 47, 55, 59, 136, 231, and 234 serve as main routes between the various municipalities. A number of rail lines also traverse the county. These transportation routes are identified in **Figure 2-2**.

According to the Indiana Business Research Center, nearly than 8%, or nearly 2,000 people commute into Montgomery County on a daily basis. Approximately 38% of these commuters travel from Fountain County. Further, approximately 2,300 Montgomery County residents commute to other counties with the majority traveling to Tippecanoe County (41%).

Figure 2-3 indicates the number of workers 16 and older who do not live within Montgomery County but commute into Montgomery County for employment purposes. Similarly, **Figure 2-4** indicates the number of Montgomery County residents 16 and older that commute out of the county for employment.

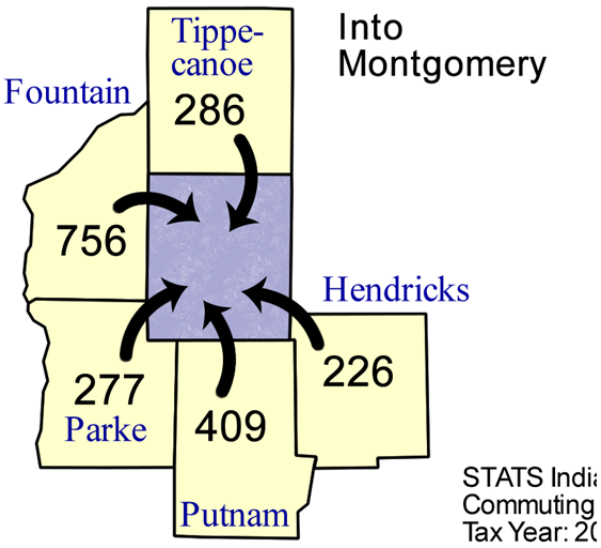


Figure 2-3 Workers Commuting into Montgomery County

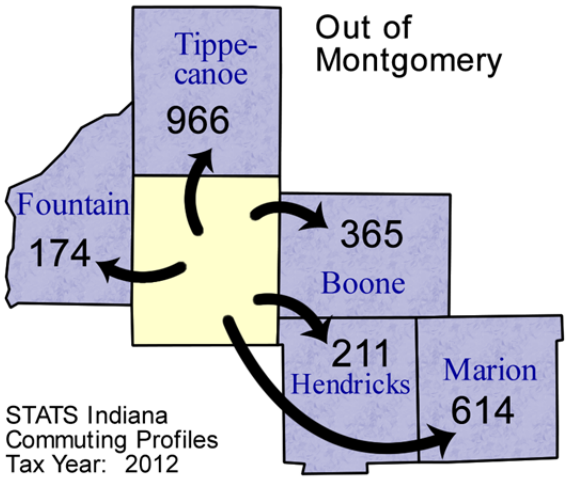


Figure 2-4 Workers Commuting out of Montgomery County

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 Montgomery County EMA provided the listing and locations of the following 246 critical infrastructure points for the MHMP Update:

- 1 Airport
- 26 Daycare Centers
- 26 Communication Towers
- 10 Dams
- 1 Emergency Operations Center
- 13 Fire Departments
- 20 Power Substations
- 12 Fire Departments
- 51 Hazardous Materials Facilities
- 48 Healthcare Facilities
- 11 Law Enforcement Facilities
- 1 Military Installation
- 7 Potable Water Treatment Facilities
- 18 Schools
- 1 State Park
- 1 Transportation Facility
- 11 Wastewater Treatment Structures

Information provided by the EMA, GIS Department, and the MHMP Planning Committee members was utilized to identify the types and locations of critical

structures throughout Montgomery County. Draft maps were provided to the EMA and Planning Department for their review and all comments were incorporated into the maps and associated databases.

Exhibit 1 illustrates the critical infrastructure identified throughout Montgomery County. **Appendix 4** lists the critical structures in Montgomery County by NFIP 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 on critical structures; thus, non-critical structures are not mapped or listed.

2.5 MAJOR WATERWAYS AND WATERSHEDS

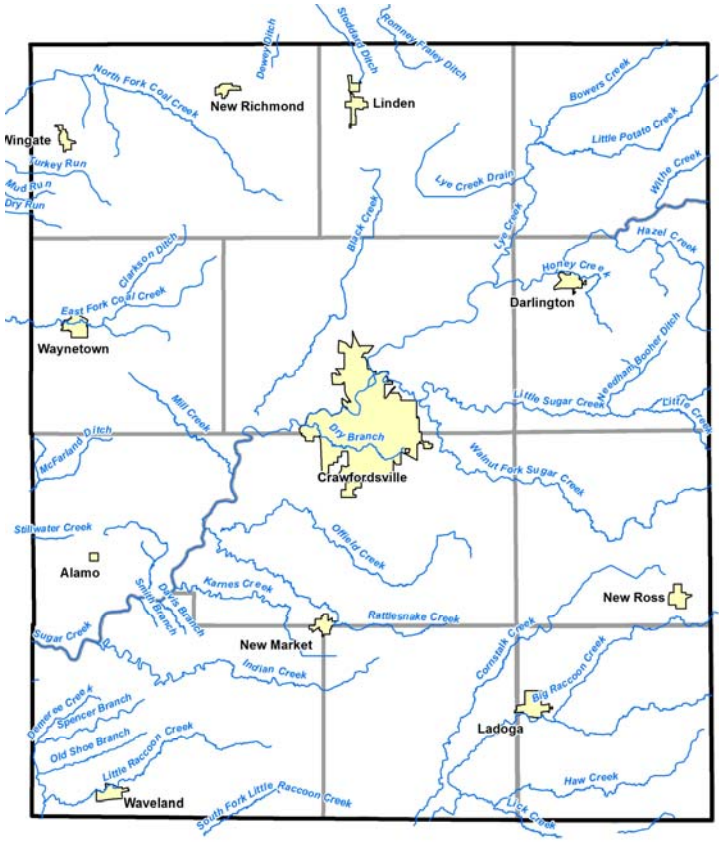


Figure 2-5 Montgomery County Waterways

According to the United States Geological Survey (USGS) there are 50 waterways in Montgomery County; they are listed in Appendix 5. The County's main waterways are the Big Raccoon Creek, Little Sugar Creek, and Sugar Creek and the county lies within two 8-digit Hydrologic Unit Codes (HUC): the Middle Wabash-Little Vermillion (05120108), and the Sugar (05120110). These major waterways are identified on **Figure 2-5**.

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.

Montgomery County, the City of Crawfordsville, the Town of Darlington, the Town of Waveland, and the Town of Waynetown are participants in the NFIP. Any smaller communities within Montgomery County may also be provided coverage by the MHMP through the County's program.

Since the development of the 2007 Montgomery County MHMP, these communities continue to participate in the NFIP program. These NFIP communities have also adopted Flood Hazard Ordinances containing language regarding compensatory floodplain storage.

At the time of preparing this MHMP, none of the NFIP entities in Montgomery County participate in the CRS program. The CRS program 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 3 goals of the CRS: 1) reduce flood losses; 2) facilitate accurate insurance rating; and 3) promote education and awareness of flood insurance. For CRS participating communities, flood insurance premium rates are discounted in increments of 5% for each class level achieved. **Table 2-2** lists the NFIP number, effective map date, and the date each community joined the NFIP program.

Table 2-2 NFIP Participation

NFIP COMMUNITY	NFIP NUMBER	EFFECTIVE MAP DATE	JOIN DATE
Montgomery County	180445#	02/02/2012	06/01/1998
City of Crawfordsville	180171#	02/02/2012	02/01/1994
Town of Darlington	180321#	08/02/2011	05/25/1978
Town of Waveland	180174#		05/25/1984
Town of Waynetown	180364#	02/02/2012	03/08/2013

(FEMA, 2015)

2.7 TOPOGRAPHY

Montgomery County is bordered geographically to the east by Boone, Clinton, and Hendricks Counties, to the west by Fountain and Parke Counties, to the North by Tippecanoe County, and to the south by Putnam County. The County's landscape consists primarily of flat or gently rolling terrain built from glacial outwash materials. One exception is in the southwest corner of the county, where glacial runoff scoured deep enough to expose underlying ancient limestone bedrock. Land elevation ranges from 940.76 feet at the highest point to 598.21 feet at the lowest, and the mean is 802.34 feet NGVD

2.8 CLIMATE

The Midwestern Regional Climate Center (MRCC) provided climate data that includes information retrieved from a weather station located in Lafayette, identified as station USC00124715. This is the nearest MRCC station to Crawfordsville. The average annual precipitation is 38.91 inches per year, with the wettest month being May averaging 4.64 inches of precipitation and the driest month being February with an average of 1.98 inches of precipitation. The highest 1-day maximum precipitation was recorded in June of 2004 with 4.51 inches of rain. On average, there are 73.2 days of precipitation greater than or equal to 0.1 inches; 26.3 days with greater than or equal to 0.5 inches; and 9.0 days with greater than or equal to 1.0 inch of precipitation.

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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 Montgomery County and the NFIP communities is based on the methodology described in the Local Multi-Hazard Mitigation Planning Guidance published by FEMA in 2008 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 comparative hazard ranking with other methodologies used by the Montgomery County EMA; 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, technological, and political hazards from the 2007 Montgomery County MHMP and discussed recent and the potential for future hazard events. The Committee identified those hazards that affected Montgomery County and the NFIP communities and selected the hazards to study in detail as part of this planning effort. As

shown in **Table 3-1** these include: dam failure; drought; earthquake; extreme temperature; flooding; hailstorms, thunderstorms, and windstorms; hazardous materials incident; snow storms and ice storms; tornado; and wildfire.

All hazards studied with the 2007 Montgomery County MHMP are included in the update. Other hazards like those identified on the draft Hazard Identification and Risk Assessment (HIRA) tool being developed by IDHS were discussed but the Committee agreed that either these hazards were addressed in other documents or have little local impact and were therefore not studied in detail as a part of this planning effort.

Table 3-1 Hazard Identification

TYPE OF HAZARD	LIST OF HAZARDS	DETAILED STUDY	
		2007 MHMP	MHMP UPDATE
Natural	Drought	Yes	Yes
	Earthquake	Yes	Yes
	Extreme Temperature	Yes	Yes
	Flood	Yes	Yes
	Hail/Thunder/Wind	Yes	Yes
	Snow / Ice Storm	Yes	Yes
	Tornado	Yes	Yes
	Wildfire	Yes	Yes
Technological	Dam Failure	Yes	Yes
	Hazardous Material Incident	Yes	Yes

3.2 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 CBBEL) 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.

3.2.1 **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:

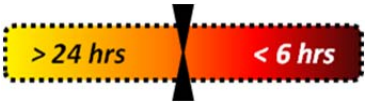
- Unlikely – incident is possible, but not probable, within the next 10 years (1)
- Possible – incident is probable within the next 5 years (2)
- Likely - incident is probable within the next 3 years (3)
- Highly Likely – incident is probable within the next calendar year (4)

3.2.2 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 6 hours (1)
- Limited – few injuries OR critical infrastructure shut down for more than 1 week OR more than 10% property damaged OR average response duration of less than 1 day (2)
- Critical – multiple injuries OR critical infrastructure shut down of at least 2 weeks OR more than 25% property damaged OR average response duration of less than 1 week (3)
- Significant – multiple deaths OR critical infrastructure shut down of r1 month or more OR more than 50% property damaged OR average response duration of less than 1 month (4)

3.2.3 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 (1)
- 12-24 hours (2)
- 6-12 hours (3)
- Less than 6 hours (4)

3.2.4 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 6 hours (1)
- Less than 1 day (2)
- Less than 1 week (3)
- Greater than 1 week (4)

3.2.5 Calculating the CPRI

The following calculation illustrates how the index values are weighted and 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 NFIP community in Montgomery County, and then a weighted CPRI value was computed based on the population size of each community. **Table 3-2** 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 3-2 Determination of Weighted Value for NFIP Communities

NFIP COMMUNITY	POPULATION (2014)	% OF TOTAL POPULATION	WEIGHTED VALUE
Montgomery County	19,945	52.3%	0.52
Town of Darlington	839	2.2%	0.02
City of Crawfordsville	15,988	41.9%	0.42
Town of Waveland	420	1.1%	0.01
Town of Waynetown	954	2.5%	0.03
TOTAL	**38,146**	**100.0**	**1.0**

3.3 HAZARD PROFILES

The hazards studied for this report are not equally threatening to all communities throughout Montgomery County. While it would be difficult to predict the probability of an earthquake or tornado affected 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 on another hazard.

Natural Hazards

3.3.1 Drought

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.

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; focusing 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 sources. **Figure 3-1** shows soil affected by drought conditions.

Figure 3-1 Drought Affected Soil

Drought: Recent Occurrences

Data gathered from the U.S. Drought Monitor indicated that between March 2007 and March 2016, there were 16 weeks where some portion of Montgomery County was considered to be in a “Severe Drought”, 7 weeks in an “Extreme Drought”, and 3 weeks in an “Exceptional Drought”. **Figure 3-2**, from the U.S. Drought Monitor, describes the rational to classify the severity of droughts. Those weeks of Extreme and Exceptional Drought are all associated with the summer 2012 event.

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 3-2 US Drought Monitor Drought Severity Classification

In July and August 2012, nearly 100% of Indiana was experiencing drought conditions ranging from "D0-Abnormally Dry" to "D4-Exceptional Drought". **Figure 3-3** identifies those areas and categories of drought throughout Indiana for August 7, 2012. Montgomery County is primarily located in the "D3-Extreme" with the far southwestern border located in the "D4-Exceptional" zone. D3 includes the potential impacts of major crop and pasture losses and widespread water shortages and restrictions. D4 includes exceptional and widespread crop or pasture losses are likely and shortages of water in reservoirs, streams and wells creating water emergencies. The August 21, 2012 report shows all of Montgomery County within the "D2-Severe Drought" consideration. It wasn't until the October 30, 2012 report that the entire county was considered out of drought condition status.

No property or crop losses have been documented in Montgomery County specific to the 5 events listed by the National Climate Data Center (NCDC) between January 2007 and December 2015. Four of these events were related to the 2012 drought. One narrative regarding the October 2010 event indicated that a countywide burn ban was in effect. Narratives throughout the 2012 event reported severely dry weather, burn bans, and record low rainfall amounts.

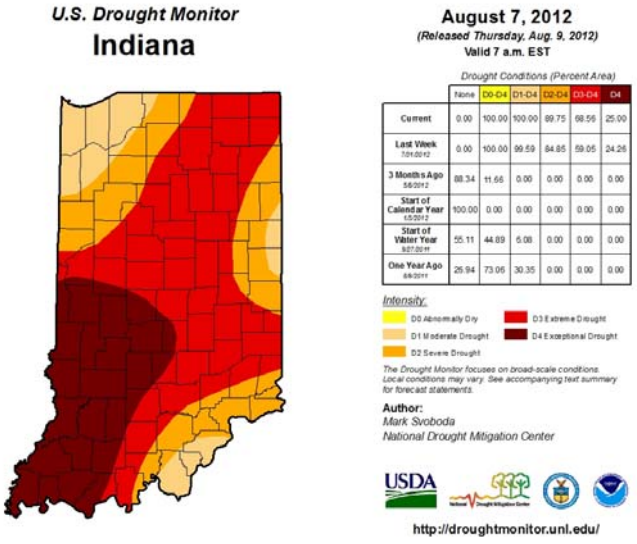


Figure 3-3 August 2012 Indiana Drought Map

The Planning Committee, utilizing the CPRI, determined the overall risk of drought throughout Montgomery County is "Elevated". The impact of drought was determined to the same for all communities within Montgomery County. The committee agreed that a drought is "Likely" (to occur within the next 3 years) and the magnitude of drought is anticipated to range from "Negligible" to "Critical". 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 1 week. A summary is shown in **Table 3-3**.

Table 3-3 CPRI for Drought

	PROBABILITY	MAGNITUDE/ SEVERITY	WARNING TIME	DURATION	CPRI
Montgomery County	**Likely**	**Critical**	**> 24 Hours**	**> 1 Week**	**Elevated**
Town of Darlington	**Likely**	**Negligible**	**> 24 Hours**	**> 1 Week**	**Elevated**
City of Crawfordsville	**Likely**	**Limited**	**> 24 Hours**	**> 1 Week**	**Elevated**
Town of Waveland	**Likely**	**Negligible**	**> 24 Hours**	**> 1 Week**	**Elevated**
Town of Waynetown	**Likely**	**Negligible**	**> 24 Hours**	**> 1 Week**	**Elevated**

According to the National Drought Mitigation Center, scientists have difficulty predicting droughts more than 1 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 droughts and drought related impacts felt within Montgomery County, the Committee estimated that the probability of a drought occurring in the area is "Likely"; or occurrence is probable within the next 3 years.

Drought: Assessing Vulnerability

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

Direct Effects:

- Urban and developed areas may experience revenue losses from 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 livestock and crop yields as well as increased field fires.
- Citizens served by drinking water wells 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

It is difficult to estimate the potential losses associated with a drought for Montgomery 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 2015, Montgomery County produced approximately 20.3M bushels of corn and 6.3M bushels of soybeans, as reported by the United States Department of Agriculture (USDA) National Agricultural Statistics Service. Using national averages of $3.85 per bushel of corn and $8.85 per bushel of soybeans, the estimated crop receipts for 2015 would be $134M. 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 $67.0M-$115.2M; depending on the crop produced and the market demand. Effects of drought on corn crops can be seen in **Figure 3-4**.

Figure 3-4 Crops Affected by Drought

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.

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". Further, "…consumers are likely to see an increase in food prices of 2.5 percent to 3.5 percent into 2013".

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 dryer seasons and therefore fewer crop losses may be experienced.

As the more urban 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.

Drought: Relationship to Other Hazards

A drought will not be caused by any other hazard studied during this planning effort. However, it is anticipated that areas of the county may be more susceptible to fires during a drought and this may lead to increased losses associated with a structural fire.

3.3.2 **Earthquake**

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.

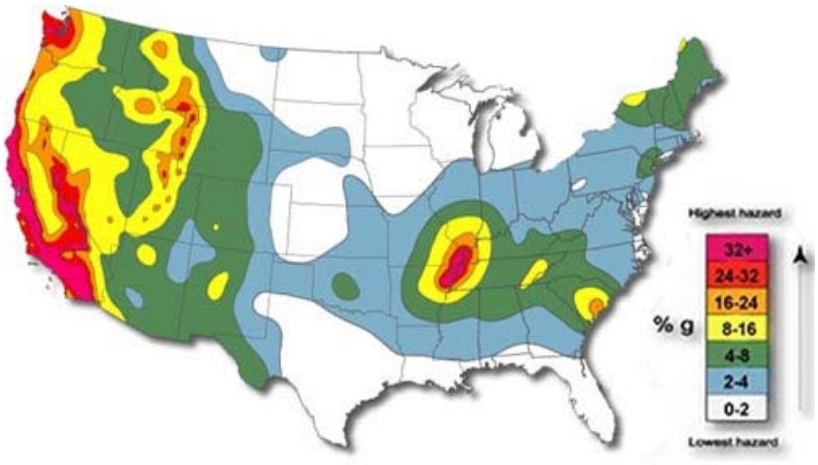


Figure 3-5 Earthquake Hazard Areas in the US

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. 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 earthquake, and they are located in every region of the country (**Figure 3-5**). 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.

Earthquake: Recent Occurrences

Indiana, as well as several other Midwestern states, lies in the most seismically active region east of the Rocky Mountains. The nearest fault is the Sharpsville Fault, which runs through southeastern Howard County and northern Tipton County.

On April 18, 2008, an M5.2 quake, reported by the Central United States Earthquake Consortium, struck southeast Illinois in Wabash County and included reports of strong shaking in southwestern Indiana, Kansas, Georgia, and the upper peninsula of Michigan. With over 25,000 reports of feeling the earthquake, there were no reports of injuries or fatalities caused by the event.

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 3-6 Earthquake Damaged Porch

Most recently, an 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, and the results of a HAZUS-MH scenario, the Committee determined that the probability of an earthquake occurring in Montgomery County or any of the communities is "Possible". Should an earthquake occur, the impacts associated with this hazard are anticipated to be "Negligible" within all areas of the County, except within the city of Crawfordsville where impacts are anticipated to be "Limited".

As with all earthquakes, it was determined that the residents of Montgomery County would have little to no warning time (less than 6 hours) and that the duration of the event would be expected to be less than 6 hours. A summary is shown in **Table 3-4**.

Table 3-4 CPRI for Earthquake

	PROBABILITY	MAGNITUDE/ SEVERITY	WARNING TIME	DURATION	CPRI
Montgomery County	**Possible**	**Negligible**	**< 6 Hours**	**< 6 Hours**	**Low**
Town of Darlington	**Possible**	**Negligible**	**< 6 Hours**	**< 6 Hours**	**Low**
City of Crawfordsville	**Possible**	**Limited**	**< 6 Hours**	**< 6 Hours**	**Elevated**
Town of Waveland	**Possible**	**Negligible**	**< 6 Hours**	**< 6 Hours**	**Low**
Town of Waynetown	**Possible**	**Negligible**	**< 6 Hours**	**< 6 Hours**	**Low**

According to 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 Montgomery County is "Possible" to occur within the next 5 years.

Earthquake: Assessing Vulnerability

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

Direct Effects:

- Urban areas may experience more damages due to the number of 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

Figure 3-7 Minor Earthquake Damages

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 3-6** and **Figure 3-7**.

Estimating Potential Losses

In order to determine the losses associated with an earthquake, the HAZUS-MH software was utilized to determine the impact anticipated from a M5.0 earthquake with an epicenter within Montgomery County.

According to the HAZUS-MH scenario, total economic loss associated with this earthquake is anticipated to be near $40.55M. 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. Total building related losses are anticipated to be $40.55M, of which 6% ($2.3M) of the estimated business losses are related to business interruption.

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. In addition to importing local building data, the Montgomery County model was further enhanced by adding localized parameters (i.e., shake maps, liquefaction, soils). 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 Montgomery 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. For that reason, Montgomery County should continue to provide education and outreach regarding earthquakes and even earthquake insurance along with education and outreach for other hazards. As Montgomery County and the communities within the County continue to 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.

Earthquake: 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 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 Montgomery County communities than the earthquake itself. It is not expected that earthquakes will be caused by other hazards studied within this plan.

3.3.3 Extreme Temperature

Extreme Temperatures: Overview

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.

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 3-8**. 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 2 consecutive days.

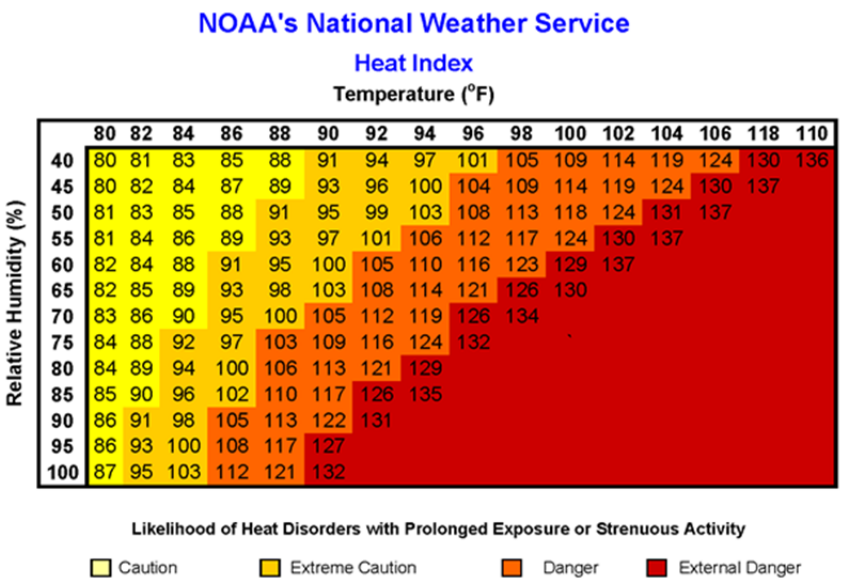


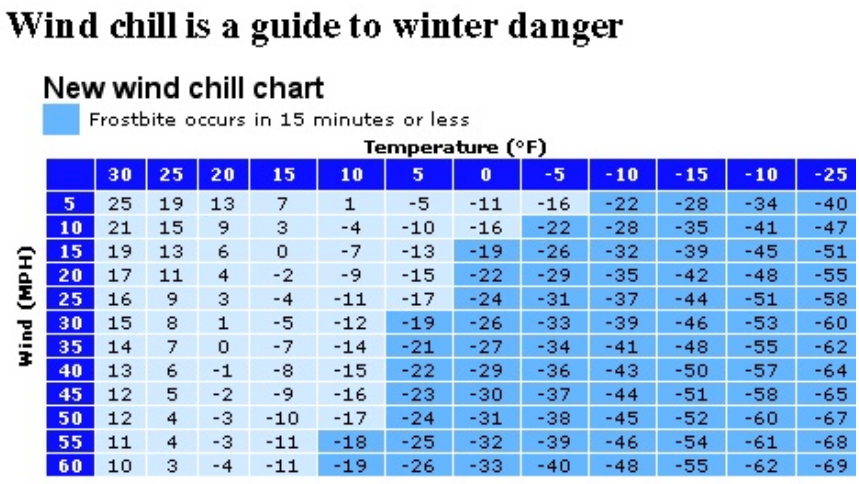
Figure 3-8 Heat Index Chart

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 3-7 indicates, there are 4 cautionary categories associated with varying heat index temperatures.

- Caution: 80°-90°F: Fatigue is possible with prolonged exposure and physical activity
- Extreme Caution: 90°-95°F: Sunstroke, heat cramps, heat exhaustion may occur with prolonged physical activity
- Danger: 105°-130°F: Sunstroke, heat cramps, or heat exhaustion is likely
- Extreme Danger: >130°F: Heatstroke is imminent

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 1 week or more. Sustained extreme cold poses a physical danger to all individuals in a community and can affect infrastructure function as well.



Wind (MPH)	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 3-9 NWS Wind Chill Chart

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 3-9** identifies the Wind Chill Chart and how the same ambient temperature may feel vastly different in varying wind speeds.

Extreme Temperature: 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 0 reported occurrences of extreme heat or extreme cold between January 2007 and December 2015. Local media outlets have provided information related to extreme temperatures occurring since the last planning effort. While not specific to Montgomery County, these reports provide a regional view of the extremes that were occurring.

In July 2012, the RTV6 *TheIndyChannel.com* reported that "The average high temperature in Indianapolis from June 28 to July 6 was a little more than 100

degrees, and Friday's high temperature of 105 was the hottest since 1936, just one degree shy of the all-time highest temperature in Indianapolis since records began in 1871". Further, the article highlighted the average temperature for the 10-day period was nearly 101 degrees. The record 10-day average high temperature of 103 degrees was set in 1936.

January 2009 brought a string of cold weather that caused school delays, emergency response delays, and several cold weather advisories. During this cold spell, Indianapolis set 2 winter records for power consumption on 2 consecutive days. Cold weather also slowed emergency response as firefighters throughout the region were delayed by slick roads, frozen hydrants, and hazards caused by water used to battle the blaze.

More recently, in January 2013 several schools delayed the start of the school day as overnight and early morning temperatures with wind chill adjustments felt like -20°. Wind chill advisories were issued through Central Indiana, residents were urged to learn the warning signs of frostbite, take special precautions for pets, and dress in many warm layers.

It is difficult to predict the probability that an extreme temperature event will affect Montgomery County residents within any given year. However, based on historic knowledge and information provided by the NFIP representatives, an extreme temperature event is "Unlikely" (possible within the next 10 years) to occur and if an event did occur, it would result in "Negligible" magnitude. **Table 3-5** identifies the CPRI for extreme temperature events for all NFIP communities in Montgomery County.

Table 3-5 CPRI for Extreme Temperatures

	PROBABILITY	MAGNITUDE/ SEVERITY	WARNING TIME	DURATION	CPRI
Montgomery County	**Unlikely**	**Negligible**	**> 24 Hours**	**> 1 Week**	**Low**
Town of Darlington	**Unlikely**	**Negligible**	**> 24 Hours**	**> 1 Week**	**Low**
City of Crawfordsville	**Unlikely**	**Negligible**	**> 24 Hours**	**> 1 Week**	**Low**
Town of Waveland	**Unlikely**	**Negligible**	**> 24 Hours**	**> 1 Week**	**Low**
Town of Waynetown	**Unlikely**	**Negligible**	**> 24 Hours**	**> 1 Week**	**Low**

As shown in the table, index values remain identical throughout each NFIP community due to the regional extent and diffuse severity of this hazard event.

Extreme Temperatures: 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.

By assessing the demographics of Montgomery County, a better understanding of the relative risk that extreme temperatures may pose to certain populations can be gained. In total, nearly 17% of the County's population is over 65 years of age, more than 6% of the population is below the age of 5, and approximately 12% 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.

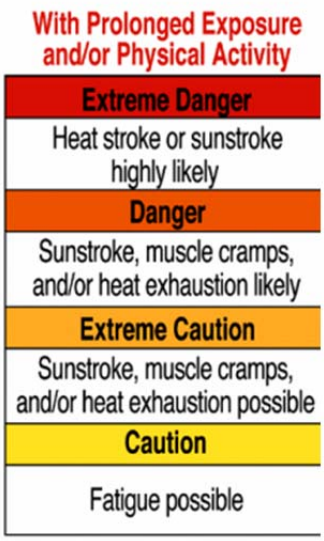


Figure 3-10 Danger Levels with Prolonged Heat Exposure

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 3-10**.

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 Montgomery 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. 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.

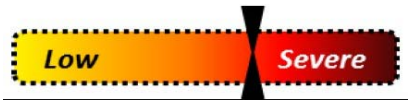
Future Considerations

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 Montgomery County's at risk populations.

<u>Extreme Temperatures: Relationship to Other Hazards</u>

While extreme temperatures may be extremely burdensome on the power supplies in Montgomery County, the Committee concluded that this type of hazard is not expected to cause any hazards studied, with the exception of a potential civil disturbance. 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.

3.3.4 **Flood**



Flood: Overview

Floods are the most common and widespread of all 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 2 or more acres of normally dry land area or of 2 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 are capable of producing damaging flash flood conditions.

The traditional benchmark for riverine or coastal flooding is a 1% annual chance of flooding, 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% annual chance flood is referred to as the "regulatory" or "base" flood. Another term commonly used, the "100-year flood", is often incorrectly used and can be misleading. It does not mean that only 1 flood of that size will occur every 100 years. What it actually means is that 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.

Flood: Recent Occurrences

The NCDC reports that between January 2007 and December 2015, there were 5 flood events (3 floods and 2 flash floods) that resulted in approximately $13.0K in property damages and an additional $1.0K in crop damages. NCDC indicates that during the April 2013 event, flooding resulted in the closure of the Lafayette Avenue Bridge, softball fields were submerged, and the Creekside Restaurant was inaccessible due to high water. **Appendix 6** provides the NCDC information regarding flood events that have resulted in injuries, deaths, or monetary damages to property and/or crops.

Figure 3-11 April 2013 Flooding

One of the more recent flooding events, not reported by NCDC, occurred in June of 2015 and greatly affected many parts of Ladoga, New Ross and parts of the County. The Montgomery County Highway Department placed signage throughout the affected areas to warn motorists of high water (**Figure 3-11**). A report by the Journal Review Online of Crawfordsville, stated "…a backyard rain gauge recorded more than 10 inches of water within a 24 hour period". A local resident was also reported to have stated "My son has lived here for seven years and we have never seen the water get so high. We have a photo of my son standing in his backyard ad the water is up to his waist".

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 Montgomery County, there is one active USGS stream gage equipped with AHPS capabilities; identified on **Exhibit 2**.

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 is one property within the unincorporated area of Montgomery County considered to be repetitive loss property.

There have been a small number of claims made for damages associated with flooding in Montgomery County. Within the City of Crawfordsville, there have been 11 paid losses resulting in approximately $160K in payments. Further, within the unincorporated areas of the County, there were 8 payments totaling approximately $193K. **Table 3-6** identifies the number of claims per NFIP community as well as payments made.

Table 3-6 Repetitive Loss Properties, Claims, and Payments

NFIP COMMUNITY	# OF REPETITIVE LOSS PROPERTIES	CLAIMS SINCE 1978	$$ PAID
Montgomery County	1	8	$193K
Darlington	0	0	$0
Crawfordsville	0	11	$160K
Waveland	0	0	$0
Waynetown	0	0	$0
TOTAL	**1**	**19**	**$353K**

(IDNR, 2015)
(FEMA Region V, 2015)

Mandatory flood insurance purchase requirements apply to structures in 1% annual chance of flooding delineated areas. Total flood insurance premiums for Montgomery County and the NFIP communities is approximately $42K. Total flood insurance coverage for Montgomery County is nearly $9M. **Table 3-7** further indicates the premiums and coverage totals for individual NFIP communities.

Table 3-7 Insurance Premiums and Coverage

NFIP COMMUNITY	FLOOD INSURANCE PREMIUMS	FLOOD INSURANCE COVERAGE
Montgomery County	$26K	$6.5M
Darlington	$0	$0
Crawfordsville	$15K	$2.2M
Waveland	$0	$0
Waynetown	$2K	$0.3M
TOTAL	**$43K**	**$8.8M**

(IDNR, 2015)

As determined by the Committee, the probability of a flood occurring throughout Montgomery County ranges from "Unlikely" in Waveland; "Possible" in Darlington; and "Likely" within the County, Crawfordsville, and Waynetown. Impacts from such an event are anticipated to range from "Negligible" to "Limited". The Committee also determined that the warning time would be vary based on proximity to warning measures and local streams, and that the duration of such an event is anticipated to last less than 1 week for most areas. A summary is shown in **Table 3-8**.

Table 3-8 CPRI for Flood

	PROBABILITY	MAGNITUDE/ SEVERITY	WARNING TIME	DURATION	CPRI
Montgomery County	**Likely**	**Limited**	**6-12 Hours**	**< 1 Week**	**Elevated**
Town of Darlington	**Possible**	**Negligible**	**12-24 Hours**	**< 1 Week**	**Low**
City of Crawfordsville	**Likely**	**Limited**	**12-24 Hours**	**< 1 Week**	**Elevated**
Town of Waveland	**Unlikely**	**Negligible**	**>24 Hours**	**< 6 Hours**	**Low**
Town of Waynetown	**Likely**	**Limited**	**12-24 Hours**	**< 1 Week**	**Elevated**

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 USGS/NWS stream gages, the NCDC, and previous experiences, the Committee determined that flooding is "Unlikely" to "Likely" throughout the county.

Flood: Assessing Vulnerability

Flood events may affect large portions of Montgomery County at one time as large river systems and areas with poor drainage cover much of the county and several communities. Within Montgomery 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

Indirect Effects:

- Increased response times for emergency personnel if 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

Estimating Potential Losses

Figure 3-12 Car Submerged on Flooded Street

Critical and non-critical structures located in regulated floodplains, poorly drained areas, or low lying areas (**Figure 3-12**) 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 the Modified Building Inventory provided by Montgomery County and structures located within each flood zone were tallied using GIS analysis techniques.

The Modified Building Inventory was created in ESRI ArcGIS by converting parcels to centroids, and joining Assessor Data to these centroids. Assessor data included square footage for the structure, and any structure that was listed as less than 400 ft^2 in area or was classified in the Assessor's database as a non-habitable structure was assumed to be an outbuilding. Also, buildings with an assessed value of $0.00 or buildings that did not match the Assessor Data (parcel numbers did not match) were excluded from the analysis. Replacement 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

The resulting Modified Building Inventory was used in the GIS analyses.

In order to estimate anticipated damages associated with each flood in Montgomery County and NFIP 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 3-9** identifies the estimated losses associated with structures in the floodway, the 100-year floodplain, and the 500-year floodplain areas by NFIP community within Montgomery County.

Table 3-9 Manual GIS Analysis Utilizing Most Recent Preliminary DFIRM Data and Montgomery County Building Inventory

	FLOODWAY		1%		0.2%		UNNUMBERED	
	#	$	#	$	#	$	#	$
Montgomery County	2	$0.2M	5	$0.8M	0	$0	177	$11.6M
Darlington	0	$0	0	$0	0	$0	2	$0.1M
Crawfordsville	35	$2.3M	53	$4.8M	27	$1.5M	3	$1.3M
Waveland								
Waynetown	0	$0	0	$0	0	$0	1	$0.5M
Total	**37**	**$2.5M**	**58**	**$5.6M**	**27**	**$1.5M**	**191**	**$13.5M**

Structures and damages within each zone are not inclusive

Utilizing the same GIS information and process, **Table 3-10** identifies the number of critical infrastructure within each of the Special Flood Hazard Areas (SFHA) in Montgomery County. These buildings are included in the overall number of structures and damage estimate information provided in Table 3-7.

Table 3-10 Critical Infrastructure in SFHA by NFIP Community

NFIP COMMUNITY	FLOODWAY	1%	0.2%	UNNUMBERED
Montgomery County				3 Dams 1 WWTP
Darlington				
Crawfordsville	1 Dam 1 Health Care	1 WWTP	1 HazMat	
Waveland				
Waynetown				
Total	**2**	**1**	**1**	**4**

Structures within each zone are not inclusive

Utilizing the information in Table 3-7 regarding the number of structures within each Flood Hazard Area, it is also important to note the number of flood insurance policies within each NFIP area in Montgomery County. **Table 3-11** provides the comparison between the number of structures in the SFHA 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 3-11 Number of Structures in the SFHA and Number of Flood Insurance Policies

NFIP COMMUNITY	# STRUCTURES IN SFHA	# POLICIES
Montgomery County	184	48
Darlington	2	0
Crawfordsville	118	18
Waynetown	11	4
Waveland	0	0
Total	**315**	**70**

(IDNR, 2015)

Future Considerations

As the municipalities within Montgomery County continue to grow in population, it can be anticipated that the number of critical and non-critical infrastructure will also increase accordingly. Location of these new facilities should be carefully considered and precautions should be encouraged to ensure that school, medical facilities, community centers, municipal buildings, and other critical infrastructure are located outside the 0.2% annual chance (500-year) floodplain and/or are 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 infrastructure will be able to continue functioning during major flood events.

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

Despite these efforts, the overall vulnerability and monitory 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.

Indirect effects of flooding may include increased emergency response times due to flooded or redirected streets (**Figure 3-13**), 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 Montgomery County are closely tied to the river systems, special events occurring near to or on these rivers and waterways may be cancelled or postponed during periods of flooding or high water levels.

<u>Flood: Relationship to Other Hazards</u>

Figure 3-13 Fire Engine in Flood Waters

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 snow storm 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.

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.

3.3.5 Hailstorms, Thunderstorms, and Windstorms

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 3-14**), 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.

Hailstorm, Thunderstorm, and Windstorm: Recent Occurrences

Figure 3-14 Damaging Hail on Vehicles

In Montgomery County, the NCDC has recorded 25 hailstorms and 35 thunderstorms/windstorms between January 2007 and December 2015. The largest recorded hailstone was 2.75 inches in diameter and has occurred on May 21, 2014 in Waveland. The average diameter hailstone occurring throughout Elkhart County is 1.2 inches.

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 Montgomery County,

NCDC reports 32 instances between January 2007 and December 2015 where top wind speeds were greater than 60 mph.

Total NCDC recorded damages for hailstorms, thunderstorms, and windstorms throughout Montgomery County are $106.25K. The NCDC also reports 1 injury where a man was injured as a falling limb struck him in the head during a thunderstorm. 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 Montgomery County. 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.

On April 19, 2011 thunderstorms and high winds up to 80 mph caused damage to trees and power lines. Most notably was approximately $43K in damages to structures at the Trinity Mission property, including shed, damages to the main building, and a flag pole.

While not reported by the NCDC, a series of storms passed through Montgomery County on July 13, 2015. Along with downed trees and power lines, several power crews worked to restore power to over 50,000 central Indiana customers, and 66 mph winds were reported near Ladoga.

According to the Institute for Business and Home Safety, central Indiana can expect to experience damaging hailstorms 3-4 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 in Montgomery County is “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 6-12 hours and the duration is expected to last less than 6 hours.

Indicative of a regional hazard, the probability, magnitude, warning time, and duration of a hailstorm, thunderstorm, or windstorm are expected to be much the same throughout the county. These events are highly unpredictable and the occurrences are distributed through the county. Therefore the CPRI values reflect the equally distributed risk and associated priority for a hailstorm, thunderstorm, or windstorm. A summary is provided in **Table 3-12**.

Table 3-12 CPRI for Hailstorm, Thunderstorm, and Windstorm

	PROBABILITY	MAGNITUDE /SEVERITY	WARNING TIME	DURATION	CPRI
Montgomery County	**Highly Likely**	**Negligible**	**6-12 Hours**	**< 6 Hours**	**Elevated**
Town of Darlington	**Highly Likely**	**Limited**	**6-12 Hours**	**< 6 Hours**	**Elevated**
City of Crawfordsville	**Highly Likely**	**Limited**	**6-12 Hours**	**< 6 Hours**	**Elevated**
Town of Waveland	**Highly Likely**	**Limited**	**6-12 Hours**	**< 6 Hours**	**Elevated**
Town of Waynetown	**Highly Likely**	**Limited**	**6-12 Hours**	**< 6 Hours**	**Elevated**

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.

Hailstorm, Thunderstorm, and Windstorm: 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 Montgomery 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

Estimating Potential Losses

Due to the unpredictability of this hazard all critical infrastructure and non-critical structures in Marion 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 more or less vulnerable to damages. However,

Figure 3-15 Home Damaged During Windstorm

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 shown in **Figure 3-15**, are common.

Future Considerations

As the populations of the communities in Montgomery County continue to 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 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, damages resulting from prolonged power outages, and damages to structures or property as a result of debris.

<u>Hailstorm, Thunderstorm, and Windstorm: Relationship to Other Hazards</u>

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 Montgomery 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 and levee failure. High winds may also lead to structural damages to a dam or levee, or may cause damages to nearby trees or other structures, leading to indirect damages to the dam or levee.

The risk of social losses also increases during a hailstorm, thunderstorm, or windstorm as many times, these hazards 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 as a result of falling debris.

3.3.6 **Tornado**

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.

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-clown 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 **Figure 3-16**. Tornadoes occur most frequently in the United States east of the Rocky Mountains. Tornadoes in Indiana generally come from the south through the east.

Figure 3-16 Funnel Cloud During a Lightning Storm at Night

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.

Tornado: Recent Occurrences

The classification of tornadoes utilizes the Fujita Scale of tornado intensity, described in **Table 3-13**. Tornado intensity ranges from low intensity (F0) tornadoes with effective wind speeds of 40-70 mph to high intensity (F5+) tornadoes with effective wind speeds of 261-318+ mph. According to the NCDC, Montgomery County has experienced 5 tornadoes (2-F0; 2-F1; 1-F2) between January 2007 and December 2015.

Table 3-13 Fujita Scale of Tornado Intensity

F-SCALE	WINDS	CHARACTER OF DAMAGE	RELATIVE FREQUENCY
F0 (weak)	40-72 mph	Light damage	29%
F1 (weak)	73-112 mph	Moderate damage	40%
F2 (strong)	113-157 mph	Considerable damage	24%
F3 (strong)	158-206 mph	Severe damage	6%
F4 (violent)	207-260 mph	Devastating damage	2%
F5 (violent)	261-318 mph	Incredible damage	<1%

A tornado reported by the NCDC occurred on February 20, 2014 and resulted in approximately $75K in property damages as it touched down near County Roads 150 South and 200 East. Several outbuildings, rooftops and trees were damaged along the path. Another event, occurring on November 17, 2013, was one of 29 tornadoes in Indiana associated with this system. Within Montgomery County, an EF-1 tornado touched down near New Richmond and caused damage to 2 buildings near the Weaver Popcorn plan. For over 2 miles, metal, insulation, and construction lumber were scattered along the tornado path.

The Committee estimated the probability of a tornado occurring in Montgomery County would be "Likely" and the magnitude and severity of such an event to be "Limited" within the County, and "Critical" if a tornado were to strike any of the municipalities. As with many hazardous events, the Committee anticipated a short warning time, less than 6 hours, and a short duration, also less than 6 hours. The summary is shown in **Table 3-14**.

Table 3-14 CPRI for Tornado

	PROBABILITY	MAGNITUDE/ SEVERITY	WARNING TIME	DURATION	CPRI
Montgomery County	**Likely**	**Limited**	**< 6 Hours**	**< 6 Hours**	**Elevated**
Town of Darlington	**Likely**	**Critical**	**< 6 Hours**	**< 6 Hours**	**Elevated**
City of Crawfordsville	**Likely**	**Critical**	**< 6 Hours**	**< 6 Hours**	**Elevated**
Town of Waveland	**Likely**	**Critical**	**< 6 Hours**	**< 6 Hours**	**Elevated**
Town of Waynetown	**Likely**	**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 probability of a future tornado occurring in Montgomery County is likely (within the next 3 years).

Tornado: 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 Montgomery County that would be more or less 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 F2 intensity tornadoes traveled through portions of the County. 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% would be 50% damaged, and 40% would have only 25% damage. These estimations were also determined utilizing 3 wind speed zones based on distance from the tornado path. Zone A is nearest the center of the tornado path, while Zone C is the farthest from the path and with a theoretical lower wind speed. **Table 3-15** provides summary data for the hypothetical tornado, which is identified on Exhibit 3.

Table 3-15 Summary of Hypothetical Tornado Damages

ZONE	NUMBER OF STRUCTURES DAMAGED	ESTIMATED DAMAGE ($)
Zone A	302	$13.3M
Zone B	236	$7.2M
Zone C	266	$10.8M

Future Considerations

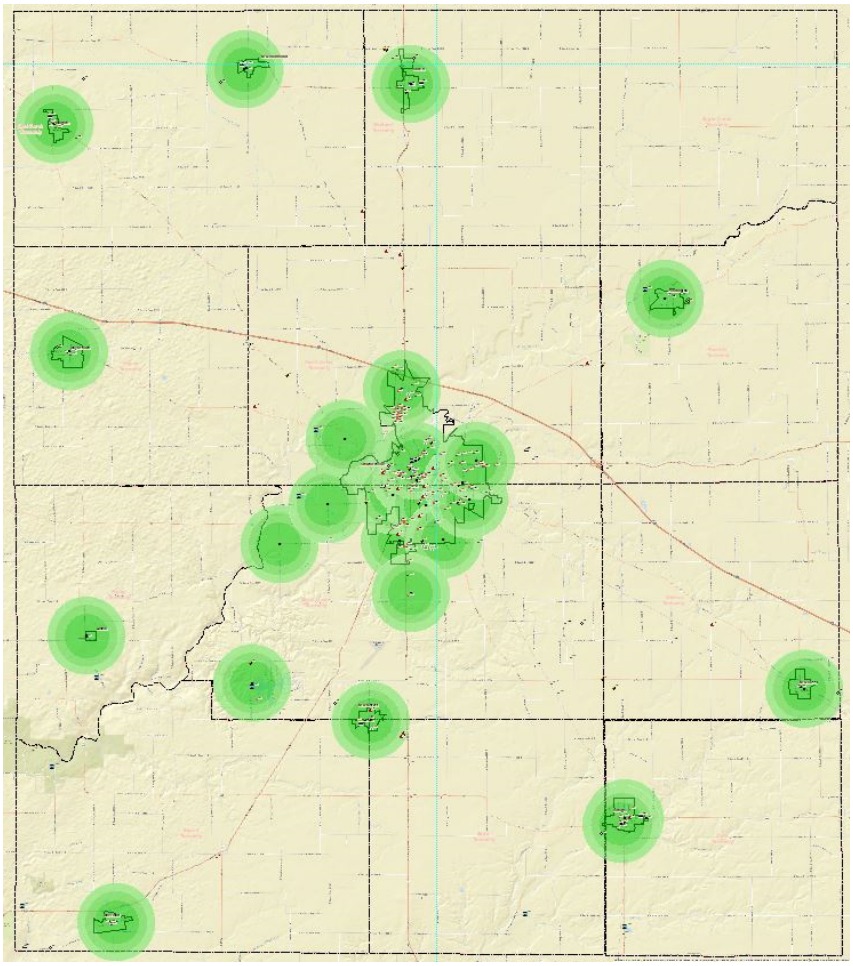


Figure 3-17 Montgomery County Outdoor Warning Sirens

Within Montgomery County, there are numerous events each year that draw thousands of guests. Due to this, it is imperative that the EMA place continued importance on the need to maintain, and as necessary, upgrade their outdoor warning siren coverage. Currently, much of the more populous areas of the County are covered by the audible ranges of the existing outdoor warning sirens. The existing siren locations and their coverage areas are provided in **Figure 3-17**.

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 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.

Tornado: 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.

3.3.7 Wildfire

Wildfire: Overview

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 lightening; 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 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. 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 may be extremely dangerous. If weather conditions change suddenly, the wildfire may change course and overtake firefighters, causing severe injury or death. Particularly dangerous are the narrow valley corridors that could act like a chimney and direct wildfire rapidly up the valley corridor. Wildfires can travel at speeds greater than 45 mph. Therefore these hazard events can pose a serious threat to County residents and response agencies.

Wildfire: Recent Occurrences

Within the NCDC, there are no reports of wildfires occurring within Montgomery County between January 1950 and December 2015. Within the same time parameter, there were only 2 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. Due to the expansive acreage of cropland and forests within Montgomery County, the Planning Committee decided to include this hazard within the MHMP, as it is a real concern, but determined the probability to be "Unlikely" according to the guidelines provided. **Table 3-16** identifies the CPRI rankings for wildfire in Montgomery County.

Table 3-16 CPRI for Wildfire

	PROBABILITY	MAGNITUDE/ SEVERITY	WARNING TIME	DURATION	CPRI
Montgomery County	**Unlikely**	**Negligible**	**<6 Hours**	**< 1 Day**	**Low**
Town of Darlington	**Unlikely**	**Negligible**	**<6 Hours**	**< 1 Day**	**Low**
City of Crawfordsville	**Unlikely**	**Negligible**	**<6 Hours**	**< 1 Day**	**Low**
Town of Waveland	**Unlikely**	**Negligible**	**<6 Hours**	**< 1 Day**	**Low**
Town of Waynetown	**Unlikely**	**Negligible**	**<6 Hours**	**< 1 Day**	**Low**

Few reports were provided for small to moderate wildfires within Indiana, but none provided information related to property or structural damages, or any injuries or deaths resulting from the fire. An article from the UPI discusses an event from 2010 affecting several counties in east-central Indiana. Several homes were evacuated and the fire reached nearly 1,000 acres. At this same time, the Mayor of Indianapolis issued a burn ban due to the extremely dry weather.

Wildfire: Assessing Vulnerability

A wildfire typically affects a large regional area with potential for physical, economic, and/or social losses. Direct and indirect effects of a such an event within Montgomery County may include:

Direct Effects:

- Loss of structures
- Loss of production crop
- Loss of natural resources

Indirect Effects:

- Loss of revenue as businesses may be closed
- Increased emergency response times based on safety of roads
- Loss of income if dependent on crop production

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 from wildfire impacts.

In general this hazard is not typically as damaging to structures or critical infrastructure as it is to cropland and natural resources such as forests and grasslands so monetary damages associated with the direct effects of the wildfire are not possible to estimate. Indirect effects would cause increased efforts associated with emergency response services as wildfires are difficult to contain and may accelerate very quickly. Large expanses of forest or grass land, such as Shades State Park and Lake Waveland may experience significant natural resource loss as well as the associated revenue from park or area visitors.

Future Considerations

As populations increase and communities continue to grow in size, the need to respond to wildfire 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.

Wildfires 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 wildfire and how it may affect those businesses directly related to cropland or natural resource areas.

Wildfire: Relationship to Other Hazards

Wildfires 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.

Wildfires 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.

3.3.8 Winter Storm & Ice

Winter Storm & 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. All winter storms are accompanied by cold temperatures and blowing snow, which can severely reduce visibility. A winter storm is one that drops 4 or more inches of snow during a 12-hour period, or 6 or more inches during a 24-hour span. An ice storm occurs when freezing rain falls from clouds and freezes immediately on impact. 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 3-18 Ice Covered Power Lines

Storm effects such as extreme cold, flooding, and snow and ice accumulation (**Figure 3-18**) can cause hazardous conditions and hidden problems for people in the affected area. 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; and 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 definitely on the way. A blizzard warning means 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 Montgomery County. Such conditions can result in substantial personal and property damage, even death.

Winter Storm & Ice: Recent Occurrences

Since the completion of the January 2007 Montgomery County MHMP, the NCDC has recorded 7 winter storms, 2 heavy snow, 1 blizzard, and 1 ice storm events. While no injuries or deaths were reported with these events, approximately $15K in property damages was reported. Narrative descriptions indicated poor travel conditions, power outages and debris associated with similar events.

Appendix 6 provides the NCDC information regarding snow storms and ice storms that have resulted in injuries, deaths, or monetary damages to property and/or crops.

The probability, magnitude, warning times, and duration of a snow storm or ice storm causing disruption to residents and businesses in Montgomery County, as determined by the Planning Committee, is expected to be consistent throughout the County and NFIP communities. It is "Highly Likely" 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 "Negligible" severity. 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 last greater than 1 week. A summary is shown in **Table 3-17**.

Table 3-17 CPRI for Winter Storm and Ice

	PROBABILITY	MAGNITUDE/ SEVERITY	WARNING TIME	DURATION	CPRI
Montgomery County	Highly Likely	Negligible	12-24 Hours	> 1 Week	Elevated
Town of Darlington	Highly Likely	Negligible	12-24 Hours	> 1 Week	Elevated
City of Crawfordsville	Highly Likely	Negligible	12-24 Hours	> 1 Week	Elevated
Town of Waveland	Highly Likely	Negligible	12-24 Hours	> 1 Week	Elevated
Town of Waynetown	Highly Likely	Negligible	12-24 Hours	> 1 Week	Elevated

The Planning Committee determined that the probability for a snow storm or ice storm to occur in Montgomery County or any of the communities within is "Highly Likely", or will occur within the calendar year. Based on historical data

and the experience of the Planning Committee, snow storms and ice storms are common within Montgomery County and will continue to be an annual occurrence.

Winter Storm & Ice: Assessing Vulnerability

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

Direct Effects:

- More urban area employers may experience loss of production as employees may not be able to get to work
- Rural (County) roads may impassable
- Expenses related to snow removal or brine/sand applications

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

Estimating Potential Losses

Given the nature and complexity of a regional hazard such as a snow storm, 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 snow storm and ice storm incidents.

For planning purposes, information collected in snow storms 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 Allen County communities. For example, a March 2003 snow storm 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

Figure 3-19 Travel Impacted During Snow Storm

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 6 counties. Snow storms and blizzards also make road travel difficult and dangerous, as in **Figure 3-19**.

The Denver, Colorado area snowstorms from December 2006 through January 2007 surpassed the expenses and damages of the 2003 winter storms. In snow removal costs alone, it is estimated that over $19M was spent throughout the area, with approximately $6.4M of that allocated to clearing Denver International Airport. Additional economic expenses are realized when such a large storm closes local businesses and Denver International Airport for nearly 48 hours.

While the above examples indicate the wide-ranging and large-scale impact that winter storms can have on a community or region, in general, winter storms 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 in size, the need to respond to snow storms 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.

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 3 quarters of 1977 to approximately -1% in the last quarter of 1977 and 3% during the first quarter of 1978.

Winter Storm & Ice: Relationship to Other Hazards

Figure 3-20 Flooding Caused by Snow Melt

Winter storms and ice storms can lead to flooding as the precipitation melts and enters local receiving water bodies. This increased volume of water on already saturated, or still frozen ground can quickly result in flooding related damages to structures and properties (**Figure 3-20**) 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 suburban/rural areas of Montgomery County, or where open areas are more susceptible to drifted 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.

TECHNOLOGICAL HAZARDS

3.3.9 Dam Failure

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.

Dam Failure: Recent Occurrences

Figure 3-21 Waveland Lake Dam

Within Montgomery County, there are 6 DNR regulated dams: 2 high hazard dams, 1 significant hazard dam, 3 low hazard dams as shown on Exhibit 2. The High Hazard dams are the Crawfordsville Community Sportsman's Club Dam and the Waveland Lake Dam (**Figure 3-21**). There have been no recorded dam failures within Montgomery County.

Based on the information provided to them, the Committee determined the probability of a dam failure is "Unlikely" to "Possible" with an anticipated effect of "Negligible" (areas not anticipated to be within the inundation area) to "Limited" (based on the number of structures or populations downstream of the dam) damages. **Table 3-18** provides a summary of the Planning Committee's expectations during a dam failure.

Table 3-18 CPRI for Dam Failure

	PROBABILITY	MAGNITUDE/ SEVERITY	WARNING TIME	DURATION	CPRI
Montgomery County	**Possible**	**Negligible**	**< 6 Hours**	**< 1 Week**	**Elevated**
Town of Darlington	**Unlikely**	**Negligible**	**> 24 Hours**	**< 6 Hours**	**Low**
City of Crawfordsville	**Unlikely**	**Negligible**	**< 6 Hours**	**< 6 Hours**	**Low**
Town of Waveland	**Possible**	**Limited**	**< 6 Hours**	**< 1 Week**	**Elevated**
Town of Waynetown	**Unlikely**	**Negligible**	**> 24 Hours**	**< 6 Hours**	**Low**

Dam Failure: Assessing Vulnerability

Within Montgomery 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

Indirect Effects:

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

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 dam to fail. Fortunately, the Waveland Lake Dam has an Incident & Emergency Action Plan (IEAP) prepared along with estimated dam failure inundation mapping.

Estimating Potential Losses

The potential dam failure inundation area for the Waveland Lake Dam was overlaid onto recent aerial photography to estimate the number of critical and non-critical structures that may be affected by a dam failure. The actual magnitude and extent of damages depend on the type of dam break, volume of water that is released, and the width of the floodplain valley to accommodate the dam break flood wave. There are 7 structures located within the potential inundation area of the Waveland Lake Dam that are anticipated to receive damages, including a WWTP. Following the same calculation of potential damages as other hazards, it is expected that damages will be near $1.0M, not including damages sustained by transportation routes or the dam itself.

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 will 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.

It is also very important to all downstream communities and property owners that all IEAPs are kept up-to-date as well as routinely exercised to ensure the greatest safety to those within the hazard area.

<u>Dam Failure: Relationship to Other Hazards</u>

With the potentially large volumes and velocities of water released during a dam breach, it can be expected that a dam failure would lead to flooding and

within the inundation areas downstream of the dam. Downstream 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.

Several other independent hazards may also lead to a dam failure. Hazards such as flooding, the melting of snow or ice, or rapid precipitation associated with thunderstorms, may all lead to increased pressure on the dam structures or overtopping of the structures, leading to failure. Additionally, earthquakes or tornadoes may cause damage to the structures or earthen components of the dam resulting in irreparable damages or failure.

3.3.10 **Hazardous Materials Incident**

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 may require fire, safety/law enforcement, search and rescue, and hazardous materials response units.

Figure 3-22 Drums of Potentially Hazardous Waste

As materials are mobilized for treatment, disposal, or transport to another facility, all infrastructure, facilities, and residences in close proximity to the transportation routes are at an elevated risk of being affected by a hazardous materials release. Often these releases can cause serious harm to Montgomery County and its residents if proper and immediate actions are not taken. Most releases are the result of human error or improper storage (**Figure 3-22**), 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.

Hazardous Materials Incident: Recent Occurrences

During conversations with Committee members and through information provided by local news outlets, it was noted that no significant 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 increase the likelihood of an incident.

According to the Committee, the probability of a hazardous materials release or incident is “Unlikely” to “Likely” within the areas of the County and “Negligible” to “Critical” damages are anticipated to result from an incident

dependent upon the location of the incident. As with hazards of this nature, a short warning time of less than 6 hours and a varied duration, are anticipated in the event of a hazardous materials incident. A summary is shown in **Table 3-19**.

Table 3-19 CPRI for Hazardous Materials Incident

	PROBABILITY	MAGNITUDE/ SEVERITY	WARNING TIME	DURATION	CPRI
Montgomery County	**Likely**	**Negligible**	**< 6 Hours**	**< 1 Week**	**Elevated**
Town of Darlington	**Unlikely**	**Negligible**	**< 6 Hours**	**< 1 Day**	**Low**
City of Crawfordsville	**Possible**	**Critical**	**< 6 Hours**	**< 1 Week**	**Elevated**
Town of Waveland	**Unlikely**	**Negligible**	**< 6 Hours**	**< 1 Day**	**Low**
Town of Waynetown	**Unlikely**	**Negligible**	**< 6 Hours**	**< 1 Day**	**low**

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

Hazardous Materials Incident: Assessing Vulnerability

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

Direct Effects:

- More densely populated areas with a larger number of structures, railroad crossings, and heavily traveled routes are more vulnerable
- Expense of re-construction of affected structures

Indirect Effects:

- Loss of revenue or production while recovery and/or reconstruction occurs
- Anxiety or stress related to event
- Potential evacuation of neighboring structures or facilities

While the possibility of an incident occurring may be likely, the vulnerability of Montgomery 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 Commission (LEPC). This commission has the responsibility for preparing and implementing emergency response plans, cataloging Material Safety Data Sheets (MSDS), chemical inventories of local industries and businesses, and reporting materials necessary for compliance.

In Montgomery County, several 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, the response it would require, and prevent serious affects to the community involved.

Estimating Potential Losses

Figure 3-23 Fuel Tanker Fire

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. On the other hand, 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 estimated.

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 (**Figure**

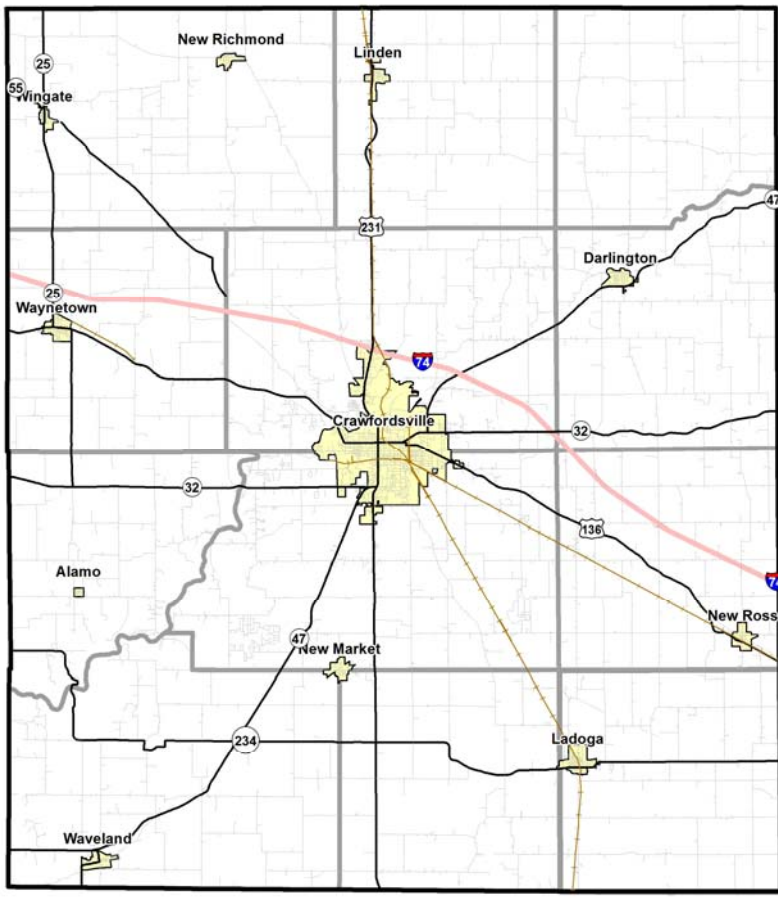


Figure 3-24 Montgomery County Transportation Routes

3-24). Several routes including railways, Interstate 74, and State Routes 25, 32, 47, 55, 59, 136, 231, and 234 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 especially should be 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, reducing the risk to highly populated buildings and potentially populations with specials needs or considerations such as children, elderly, and medically unfit.

Hazardous Materials Incident: Relationship to Other Hazards

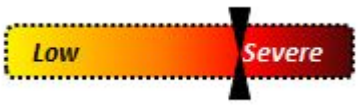
Dependent on the nature of the release, conditions may exist where an ignition source such as a fire or spark is in close proximity to a flammable or explosive substance. As the fire spreads throughout the facility or the area, structural and/or property damages will increase. Response times to a hazardous materials incident may be prolonged until all necessary information is collected detailing the type and amount of chemicals potentially involved in the incident. While this may increases structural losses, it may actually decrease the social losses such as injuries or even deaths.

3.4 HAZARD SUMMARY

For the development of this MHMP, the Committee utilized the CPRI method to prioritize the hazards they felt affected Montgomery 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 NFIP communities.

Table 3-20 summarizes the CPRI values for the various hazards studied within this MHMP. The hazards that ranked as "Elevated" risk were drought; earthquake; flooding; hail, thunder and windstorm; hazardous materials incident; tornado; and winter storm and ice storm. The hazards with a "Low" risk were dam failure; extreme temperatures; and wildfire.

Table 3-20 Combined CPRI

TYPE OF HAZARD	LIST OF HAZARDS	WEIGHTED AVERAGE CPRI
Natural	Drought	
	Earthquake	
	Extreme Temperature	
	Flood	
	Hail/Thunder/Windstorm	
	Tornado	
	Wildfire	
	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 3-21** 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 3-21 Hazard Relationship Table

EFFECT → / CAUSE ↓	Drought	Earthquake	Extreme Temperatures	Flooding	Hailstorm, Thunderstorm, Windstorm	Tornado	Winter Storm, Ice	Wildfire	Dam Failure	Hazardous Materials
Drought										
Earthquake									X	X
Extreme Temperatures										
Flooding									X	X
Hailstorm, Thunderstorm, Windstorm				X					X	X
Tornado									X	X
Winter Storm, Ice				X					X	X
Wildfire										X
Dam Failure				X						X
Hazardous Materials										

As a method of better identifying the potential relationships between hazards, Exhibit 2 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, the City of Crawfordsville or any other community 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 this facility experiencing a hazardous materials incident.

Future development in areas where multiple known hazard areas (dam failure inundations 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.

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CHAPTER 4 MITIGATION GOALS AND PRACTICES

This section identifies the overall goal for the development and implementation of the Montgomery 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 2007 Montgomery County MHMP and determined that each of these remain valid and effective. In summary, the overall goal of the Montgomery 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 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. 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 Montgomery County. Mitigation measures that were included in the 2007 Montgomery County MHMP are noted as such.

<u>Emergency Services</u>

- The County maintains 23 outdoor warning sirens providing coverage for the majority of the populated areas of Montgomery County. *(2007 Measure)*
- The County has developed a centralized system for testing, maintenance, and operation of outdoor warning sirens. *(2007 Measure)*
- The County utilizes NIXEL/Everbridge for mass alerts for weather or hazardous events. *(2007 Measure)*
- Weather radios are encouraged throughout the County during presentations, events, and on the EMA website. *(2007 Measure)*

- Stream gages are utilized for flood forecasting and flood warnings for various stream levels. *(2007 Measure)*

Natural Resource Protection

- Montgomery County, the City of Crawfordsville, and the Towns of Darlington, Waveland, and Waynetown are in good standing with the NFIP Program and have flood protection ordinances which meet minimum requirements.
- The Sugar Creek Advisory Board enforces an ordinance which protects the Sugar Creek corridor to preserve the natural scenic value of the creek and to reduce further development, as well as protect citizens of the county from the adverse effects of flooding.
- The MS4 communities enforce erosion and sediment control practices during construction activities to prevent the restriction of conveyances from sedimentation. *(2007 Measure)*

Prevention

- Information related to hazard mitigation has been incorporated, where appropriate, into individual Comprehensive Land Use Plans and other long-range plans. *(2007 Measure)*
- Several representatives participate in the Indiana Association of Floodplain and Stormwater Managers (INAFSM) or are certified as a CFM. *(2007 Measure)*
- Montgomery County and the City of Crawfordsville have developed GIS databases which are used in land use planning decisions and can be utilized in HAZUS-MH "what-if" scenarios. *(2007 Measure)*
- The Montgomery County LEPC provides routine training regarding the proper storage, transport, and disposal of hazardous materials. *(2007 Measure)*
- Electric providers routinely complete preventative maintenance on trees within the ROW and utility corridor. *(2007 Measure)*
- Local developers routinely bury new and retrofitted utilities to minimize exposure to hazards. *(2007 Measure)*
- The City of Crawfordsville continues to implement the erosion and sediment control BMPs identified in the Storm Water Quality Management Plan (SWQMP) required by Rule 13 *(2007 Measure)*

Property Protection

- All communities follow the International Building Code which includes requirements to minimize damages from natural hazards.

Public Information

- Outreach materials are routinely provided within office and agencies throughout Montgomery County, large public events, speaking opportunities within schools, etc. *(2007 Measure)*

Structural Control

- Stormwater conveyances and regulated drains are maintained on a routine basis to prevent localized flooding, increased erosion, and material deposition as a result of rainfall or snowmelt. *(2007 Measure)*
- Waveland Lake Dam is routinely inspected as required by IDNR *(2007 Measure)*
- Law enforcement officers issue citations for vehicles not following the proper transportation routes through communities; reducing the risk potential for hazardous materials to be released in residential areas.

4.2.2 **Proposed Mitigation Practices**

After reviewing existing mitigation practices, the Committee reviewed the list of mitigation ideas for each of the hazards studied as a part of this planning effort 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** – the proposed 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** – the proposed mitigation project will be technically feasible, reduce losses in the long-term, and will not create more problems than they solve.
- **Administrative** – the proposed mitigation projects may require additional staff time, alternative sources of funding, and have some maintenance requirements.
- **Political** – the proposed mitigation projects will have political and public support.
- **Legal** – the proposed mitigation projects will be implemented through the laws, ordinances, and resolutions that are in place.

- **Economic** – the proposed mitigation projects can be funded in current or upcoming budget cycles.
- **Environmental** – the proposed mitigation projects may have negative consequences on environmental assets such as wetlands, threatened or endangered species, or other protected natural resources.

Table 4-1 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 entity, and potential funding source, associated with each proposed practice. The proposed mitigation practices are listed in order of importance to Montgomery County for implementation. Projects identified by the Committee to be of "high" local priority may be implemented within 5 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.

The benefit derived from each mitigation practice along with the estimated cost of that practice was utilized to identify the mitigation practices 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 Montgomery County. The intent of this planning effort was to identify the hazards and the extent to which they affect Montgomery 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 in order to apply for and/or receive project grants under the HMGP, PDM, FMA, and SRL. FEMA may require a MHMP under the Repetitive Flood Claims (RFC) program. 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 72 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 4-1 Proposed Mitigation Practices

MITIGATION PRACTICE	MITIGATION STRATEGY	HAZARD ADDRESSED	STATUS	PRIORITY	BENEFIT-COST RATIO	RESPONSIBLE ENTITY	FUNDING SOURCE
Geographic Information Systems 1. Update and coordinate GIS layers with location and attributes of critical infrastructure 2. 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. 3. Update HAZUS-MH Earthquake model with local soil data for more accurate damage estimates	☒ Emergency Services ☒ Nat. Res. Protection ☐ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Flood ☒ Hail/Thunder/Wind ☒ Tornado ☒ Wildfire ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** 1. GIS is used by several communities **Proposed Enhancement –** 1. Coordinate consistent layers county-wide 2. Additional training for GIS staff 3. Update with local information	High	High	GIS Departments	Existing Budget
Management of High Hazard Dams 1. Complete IEAP and annual exercise for existing and new high hazard dams 2. Review regular inspection and maintenance records of high hazard dams	☒ Emergency Services ☐ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Flood ☐ Hail/Thunder/Wind ☐ Tornado ☐ Wildfire ☐ Winter Storm/Ice ☒ Dam Failure ☐ HazMat Incident	**Ongoing –** 2. IDNR receives inspection reports and IEAP updates **Proposed Enhancements –** 1. Complete IEAP and annual exercise for Waveland Lake Dam 2. Ensure inspections are reported and required improvements and repairs are completed in a timely manner	High	High	Dam Owners EMA IDNR	Existing budget
Public Education & Outreach 1. Post information/warning signs in local parks and other public gathering places explaining what to do in case of a hazard event. 2. Develop an education and outreach campaign encouraging residents to keep in contact with their neighbors during hazard events 3. Provide multi-lingual hazard preparedness literature (warning sirens, radio stations, go-kits, insurance protection, lightning rods, etc.) during Severe Weather Awareness Week, at public facilities and events and to populations within known hazard areas such as floodplains, downstream of a dam, near hazmat facilities, etc. *(2007 Measure)*	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Flood ☒ Hail/Thunder/Wind ☒ Tornado ☒ Wildfire ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** 3. Literature is provided at several public facilities and office locations as well as large public events throughout the County. Populations within the special flood hazard areas are educated through required flood insurance purchases and various website and literature pieces. **Proposed Enhancement –** 1. Post information in parks and other gathering places 2. Encourage the enhancement of the messages provided to various cultural groups and neighborhoods; Educate landowners within the dam inundation areas of the potential dangers and what to do in an emergency situation. Such as encourage voluntary purchase of federally-subsidized flood insurance; formalize a neighborhood or local campaign where community representatives familiar with the culture and language provide residents with emergency information and protocols.	High *(post info, education campaign)* Moderate *(literature*	High	EMA Red Cross Municipal Offices *(County, Crawfordsville, Darlington, Waveland, Waynetown)* Parks Departments Event Liaisons	Existing budget Grant

MITIGATION PRACTICE	MITIGATION STRATEGY	HAZARD ADDRESSED	STATUS	PRIORITY	BENEFIT-COST RATIO	RESPONSIBLE ENTITY	FUNDING SOURCE
Emergency Preparedness & Warning 1. Purchase additional mobile electronic messaging boards and develop protocol for local interactions to provide current hazard information. 2. Improve planning and coordination among event coordinators, facility owners, and emergency response teams 3. Evaluate outdoor warning siren coverage to determine if adequate to alert population of severe weather conditions 4. Continue to utilize social media to alert residents and visitors of hazardous conditions and response or recovery efforts 5. Evaluate and utilize flood forecasting capabilities including stream gages, flood forecast maps, and flood alerts 6. Convey flood height warnings from the USGS river gages in terms the general public can understand 7. Require weather radios in all critical infrastructure and encourage use by residents and businesses. 8. Improve disaster preparedness and emergency response at the local level through the CERT program 9. Increase awareness and participation in the Everbridge notification system 10. Coordinate with private business owners utilizing large dynamic message boards for business to provide messages during hazardous events and recovery efforts. 11. Install permanent dynamic message board on I-74 to provide current hazard information 12. Investigate the potential to develop a siren fund through payments made during development of subdivisions or industrial/commercial areas	☒ Emergency Services ☐ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Flood ☒ Hail/Thunder/Wind ☒ Tornado ☒ Wildfire ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** 1. Limited number of mobile electronic messaging boards. 3. Populated areas are covered by outdoor warning sirens 4. Social media is utilized by several County and municipal offices 5. The County has 1 real-time AHPS Stream Gage 7. Many critical facilities have weather radios 9. The County uses Everbridge to send mass alerts **Proposed Enhancements –** 1. Purchase additional message boards and develop protocol 2. Continue to work with event coordinators and facility owners to improve planning for hazard events 3. Purchase and install additional outdoor warning sirens as feasible 4. Increase awareness and participation in available social media outlets 5. Install additional stream gages, especially upstream of Crawfordsville near Darlington 6. Develop information for providing flood height warnings from the USGS to the general public 7. Propose and adopt an ordinance requiring a weather radio in all critical infrastructure 8. Conduct additional CERT trainings to ensure representatives in each of the NFIP communities 9. Increased number of subscribers 10. Develop a list of partnering private businesses willing to display hazard related messages 11. Coordinate with INDOT to investigate the feasibility of adding a permanent message board 12. Review, propose and adopt an ordinance creating a siren fund	High *(message boards, improved planning, sirens, forecasting, social media, flood height warnings, additional gages)* Moderate *(radios, CERT, Everbridge,* Low *(Private message boards, permanent message boards, siren fund*	High	EMA Red Cross Floodplain Administrators *(County, Crawfordsville, Darlington, Waveland, Waynetown)* Large facility or event coordinators Montgomery County Surveyor INDOT	Existing budgets Grants

MITIGATION PRACTICE	MITIGATION STRATEGY	HAZARD ADDRESSED	STATUS	PRIORITY	BENEFIT-COST RATIO	RESPONSIBLE ENTITY	FUNDING SOURCE
Building Protection 1. Review construction standards and building codes to ensure that hazard protection, especially of critical facilities, are incorporated into local building codes 2. Enforce zoning laws and prohibit the development of new critical infrastructure in 1% & 0.2% annual chance flood hazard and potential dam failure inundation areas. *(2007 Measure)* 3. Certify that mobile homes meet manufacturer's minimum installation standards (enforcing tie down and anchoring) 4. Develop reciprocal agreements for structural inspections following hazardous events 5. Protect existing critical facilities in floodplains *(Will assist with NFIP compliance)*	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☐ Drought ☒ Earthquake ☐ Extreme Temperature ☒ Flood ☒ Hail/Thunder/Wind ☒ Tornado ☐ Wildfire ☐ Winter Storm/Ice ☐ Dam Failure ☐ HazMat Incident	**Ongoing –** 1. The County and all municipalities follow the Indiana State Building Code 2. Ordinances prohibit construction of new critical facilities within the 0.2% annual chance flood area. **Proposed Enhancements –** 1. Review codes to determine if local additions may be warranted 2. Continue to discourage development within floodplains, include potential dam inundation areas. 3. Specify inspection of mobile home tie downs and anchors when inspection other aspects of mobile home installation. 4. Develop agreements for post-event inspections 5. Protect the Alcoa Closure Systems (0.2%-Crawfordsville), the Montgomery County Free Clinic (floodway-Crawfordsville); the Ladoga WWTP (Zone A-County); and the Crawfordsville WWTP (1%-Crawfordsville)	High	Moderate	Building Departments *(County, Crawfordsville)* EMA Floodplain Administrators *(County, Crawfordsville, Darlington, Waveland, Waynetown)* County Surveyor / Drainage Board	Grant Existing budget
Community Rating System 1. Reduce flood insurance premiums through increased participation or advancement in the NFIP's CRS Program. *(2007 Measure)* *(Will assist with NFIP compliance)*	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☒ Flood ☐ Hail/Thunder/Wind ☐ Tornado ☐ Wildfire ☐ Winter Storm/Ice ☐ Dam Failure ☐ HazMat Incident	**Ongoing –** **Proposed Enhancement –** 1. Participation from Montgomery County and/or Crawfordsville	High	Moderate	Floodplain Administrators *(County, Crawfordsville, Darlington, Waveland, Waynetown)*	Existing budget Grant

MITIGATION PRACTICE	MITIGATION STRATEGY	HAZARD ADDRESSED	STATUS	PRIORITY	BENEFIT-COST RATIO	RESPONSIBLE ENTITY	FUNDING SOURCE
Floodplain Management 1. Encourage restoration of the natural stream corridor in new and redevelopment projects 2. Conduct detailed hydraulic analyses of areas with repetitive flooding problems and unnumbered Zone A streams to determine floodplain boundaries. *(2007 Measure)* 3. Support FEMA approved flood depth mapping (RiskMAP) to better show the flood risk potential 4. Create fluvial erosion hazard mapping to identify critical infrastructure that may be impacted by natural stream movement *(Will assist with NFIP compliance)*	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☒ Flood ☒ Hail/Thunder/Wind ☐ Tornado ☐ Wildfire ☐ Winter Storm/Ice ☒ Dam Failure ☐ HazMat Incident	**Ongoing –** **Proposed Enhancements –** 1. Propose and adopt an ordinance that may not prohibit development, but encourages restoration of the stream corridor 2. Complete analyses as appropriate to determine floodplain boundaries and flood depth grid mapping to include all flood prone areas within the County. Implement flood protection study recommendations as feasible 3. Support flood depth mapping for prioritized areas 4. Create the fluvial erosion hazard mapping	High	Moderate	Floodplain Administrators *(County, Crawfordsville, Darlington, Waveland, Waynetown)* Planning Departments *(County, Crawfordsville)* County Surveyor / Drainage Board	Existing budget Grant
Hazardous Materials Response Team 1. Maintain LEPC reporting and training efforts as required through SARA Title III and ensure current facility maps and response plans are on file for Tier II facilities. 2. Increase number of personnel for fire departments and emergency response teams as well as those certified to OSHA III Technician level	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Flood ☐ Hail/Thunder/Wind ☐ Tornado ☐ Wildfire ☐ Winter Storm/Ice ☐ Dam Failure ☒ HazMat Incident	**Ongoing –** 1. Records are maintained for most Tier II facilities **Proposed Enhancement –** 1. Efforts should be strengthened to ensure requirements are met. 2. Additional personnel should be trained to a higher response qualification as appropriate	High	Moderate	LEPC EMA Fire Departments *(County, Crawfordsville, Townships, Volunteers)* Tier II Facility Owners	Existing Budget

MITIGATION PRACTICE	MITIGATION STRATEGY	HAZARD ADDRESSED	STATUS	PRIORITY	BENEFIT-COST RATIO	RESPONSIBLE ENTITY	FUNDING SOURCE
Stormwater Management 1. Minimize impacts of flooding by diverting or retaining stormwater onsite using green infrastructure practices 2. Maintain channels and regulated drains to prevent localized flooding 3. Address flooding in low lying and urban areas due to poor drainage	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☐ Public Information ☐ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☒ Flood ☒ Hail/Thunder/Wind ☐ Tornado ☐ Wildfire ☐ Winter Storm/Ice ☒ Dam Failure ☐ HazMat Incident	**Ongoing –** 1. Channels and regulated drains are maintained as funding and staffing allow **Proposed Enhancement –** 1. Increase use of green infrastructure as feasible 2. Continue to maintain channels and drains 3. Investigate causes of non-riverine flooding	High	Moderate	Stormwater Department *(Crawfordsville)* Montgomery County Surveyor Floodplain Administrators *(County, Crawfordsville, Darlington, Waveland, Waynetown)*	Existing Budget Grant
Transportation 1. Reduce the number of railroad/street crossing throughout Montgomery County	☒ Emergency Services ☐ Nat. Res. Protection ☒ Prevention ☐ Property Protection ☐ Public Information ☒ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☐ Flood ☐ Hail/Thunder/Wind ☐ Tornado ☐ Wildfire ☐ Winter Storm/Ice ☐ Dam Failure ☒ HazMat Incident	**Ongoing –** 1. Municipal departments are coordinating long range planning to include various measures to reduce the number of crossings **Proposed Enhancement –** 1. Continue to implement planning efforts as funding becomes available	High	Moderate	County Highway Planning Departments *(County, Crawfordsville, Darlington, Waveland, Waynetown)*	Existing Budget Grant
Tree Maintenance 1. Maintain trees on public property and right-of-ways and encourage maintenance on private property to reduce the risk of downed utility lines and falling limbs	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☐ Drought ☒ Earthquake ☐ Extreme Temperature ☐ Flood ☒ Hail/Thunder/Wind ☒ Tornado ☒ Wildfire ☒ Winter Storm/Ice ☐ Dam Failure ☐ HazMat Incident	**Ongoing –** 1. Utility providers perform routine maintenance along ROW **Proposed Enhancement –** 1. Encourage private landowners to perform maintenance or avoid planting improper trees and shrubs	High	Moderate	County Highway Municipal Street and/or Utility Departments *(Crawfordsville, Darlington, Waveland, Waynetown)*	Existing Budget Power Suppliers

MITIGATION PRACTICE	MITIGATION STRATEGY	HAZARD ADDRESSED	STATUS	PRIORITY	BENEFIT-COST RATIO	RESPONSIBLE ENTITY	FUNDING SOURCE
Emergency Response & Recovery 1. Utilize realistic training and exercises that stimulate response conditions and scenarios for emergency responders, decision-makers, and general public 2. Coordinate communications, documentation, and record keeping between NFIP communities and agencies including a database of accurate and community specific information following each hazard event s 3. Develop and implement a voluntary immunization program for all emergency responders, inspection staff, and families 4. Designate snow routes to allow for snow removal activities 5. Develop a Standard Operating Procedure for interactions and assistance between snow plows and response vehicles to clear paths for emergencies 6. Establish procedures to alert and evacuate the populations in known hazard areas (routinely flooded areas, floodplains, dam failure areas) 7. Inventory needs for mobile data terminals in response vehicles and purchase and install as feasible	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☒ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Flood ☒ Hail/Thunder/Wind ☒ Tornado ☒ Wildfire ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** 1. Training exercises are routinely held. 7. Some vehicles have mobile data terminals **Proposed Enhancement –** 1. Continue exercises and vary scenario to include various municipal departments 2. Coordinate communications and strengthen the relationship between the communities during response efforts. 3. Develop a wide-based immunization program 4. Designate snow routes 5. Develop SOP for snow plow to assist response vehicle 6. Establish specific procedures for known problem areas 7. Complete inventory to determine if additional terminals are needed	High *(training, coordinated communications, immunization, snow routes, SOP)* Moderate *(evacuations, data terminals*	Moderate	DHS Sheriff Department Police Departments *(Crawfordsville, Darlington, Waveland, Waynetown)* Fire Departments *(County, Crawfordsville, Darlington, Townships, Volunteers)* Health Department County Highway Street/ Utility Departments *(Crawfordsville, Darlington, Waynetown)*	Existing budget Grant
Land Use Planning & Zoning 1. Incorporate hazard information, risk assessment, and hazard mitigation practices into the Comprehensive Land Use Plan and Development Review to better guide future growth and development 2. Establish overlay zones in the Zoning Ordinance to restrict development, especially critical facilities in known hazard areas or require setbacks of noncritical facilities	☒ Emergency Services ☒ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☒ Structural Control	☐ Drought ☐ Earthquake ☐ Extreme Temperature ☒ Flood ☐ Hail/Thunder/Wind ☒ Tornado ☒ Wildfire ☐ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** 2. Hazard information has been incorporated into some areas of the Comprehensive Land Use Plan **Proposed Enhancement –** 1. Increase the number of hazards considered, more definitively outline higher risk areas and those that should be avoided for future development 2. Establish overlay zones to restrict development	High *(Incorporate hazard information)* Low *(overlay zones)*	Moderate	Planning Departments *(County, Crawfordsville)*	Existing Budget

MITIGATION PRACTICE	MITIGATION STRATEGY	HAZARD ADDRESSED	STATUS	PRIORITY	BENEFIT-COST RATIO	RESPONSIBLE ENTITY	FUNDING SOURCE
Power Back-Up Generators 1. Inventory presence of generators at critical infrastructure (and fuel capacity) 2. Secure a fuel reserve to ensure that critical infrastructure are able to operate on generators for extended periods of time	☒ Emergency Services ☐ Nat. Res. Protection ☒ Prevention ☒ Property Protection ☒ Public Information ☐ Structural Control	☐ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Flood ☒ Hail/Thunder/Wind ☒ Tornado ☒ Wildfire ☒ Winter Storm/Ice ☐ Dam Failure ☐ HazMat Incident	**Ongoing –** **Proposed Enhancements –** 1. Conduct inventory of generator and fuel capacity 2. Develop agreements with local fuel providers to secure a fuel reserve	High	Low	EMA	Existing budget
Safe Rooms and Community Shelters 1. Inventory areas of need and work to establish safer rooms and community shelters in vulnerable locations (mobile home parks, critical facilities, development without basements) 2. Develop temporary and/or long-term shelter agreements within the County. Potential for tiered levels of shelters, domestic animal shelters, etc.	☒ Emergency Services ☐ Nat. Res. Protection ☐ Prevention ☐ Property Protection ☒ Public Information ☐ Structural Control	☐ Drought ☒ Earthquake ☒ Extreme Temperature ☒ Flood ☒ Hail/Thunder/Wind ☒ Tornado ☒ Wildfire ☒ Winter Storm/Ice ☒ Dam Failure ☒ HazMat Incident	**Ongoing –** 1. Many buildings have plans on where to go in the event of a hazard **Proposed Enhancement –** 1. Inventory municipal/public buildings, large employers, and vulnerable areas to determine if safest places are being utilized 2. Continue to develop and assess agreements	High *(safer rooms)* Moderate *(shelter agreements)*	Low	EMA Large gathering liaisons Salvation Army Red Cross	Existing budget

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 BUILDING PROTECTION

Review construction standards and building codes to ensure that hazard protection measures, especially of critical facilities, are incorporated into local building codes.

- Review State and International Building Codes
- Determine if localization needs to occur to protect construction in Montgomery County.
- Propose and adopt localization of codes
- Provide education and outreach to planners, developers, etc. to highlight localizations

Enforce zoning laws and evaluate the development of new critical infrastructure in 1% and 0.2% annual chance flood hazard areas and potential dam failure inundation areas.

- Review current zoning code and determine if amendments need to be made to strengthen the review process for structures in these hazard areas.
- Make any amendments necessary.
- Evaluate proposed development on a case-by-case basis and determine risk for flood damages.
- Suggest flood protection measures for any development allowed in the flood risk areas.

Certify mobile homes meet manufacturer's minimum installation standards.

- Review current mobile home installation inspection procedures.
- Enhance areas (as needed) to include minimum standards and checkpoints.
- Provide additional inspection procedures to include tie down and anchoring of structure
- Provide education materials to mobile home park owners and residents

Develop reciprocal agreements for structural inspections following hazardous events.

- Review existing structural inspection procedures
- Determine staffing and knowledge levels of municipal inspectors
- Develop agreements allowing inspectors from one municipality to conduct structural inspections in another municipality following a hazardous event.

Protect existing critical facilities in floodplains

- Review listing of critical structures within floodplains
- Complete studies to determine localized flood depths
- Provide recommendations for protection measures for each structure
- Implement recommendations as funding allows

5.2 COMMUNITY RATING SYSTEM

Reduce flood insurance premiums through increased participation and advancement in the NFIP's CRS Program.

- Review application and guidance materials and begin gathering supporting documentation.
- Complete application and calculate credits.
- Consult with ISO representative to review application prior to submission.
- Submit application for advancement within the CRS program.
- Maintain and record information as necessary for annual recertification.

5.3 EMERGENCY PREPAREDNESS & WARNING

Purchase additional mobile electronic message boards and develop protocol for local interactions to provide current hazard information.

- Maintain existing mobile message boards
- Determine number of message boards needed to adequately convey messages for typical hazard events or large public gatherings
- Determine protocol for local emergency agencies to gain access to messaging systems for permanent message boards in the area.
- Distribute additional boards to key locations throughout the county dependent on areas of risk, planned gatherings, or availability of storage space

Improve planning and coordination among event coordinators, facility owners, and emergency response teams

- Develop a template Event Response Plan for use by event planners and facility owners
- Coordinate and conduct a meeting with event/planning staff and response agencies to review the template and discuss the needs for communication between the two groups
- Conduct a table-top exercise to practice the implementation of the event response plan
- Adjust the template accordingly and present to additional event planners and facility owners

Evaluate outdoor warning siren coverage to determine if adequate to alert population of severe weather conditions

- Assess areas not covered by outdoor warning siren audible ranges
- Prioritize areas in need (based on population, location of critical facilities, etc.)
- Secure or appropriate funding and install additional sirens

Continue to utilize and increase participation in various social media outlets for preparedness and recovery efforts

- Investigate social media outlets and determine how they can be employed to provide routine updates and information.
- Determine an appropriate staff member or department to coordinate social media messages
- Increase awareness and participation in the social media outlets to ensure the largest number of residents receive updates and messages

Evaluate and utilize flood forecasting capabilities including stream gages, flood forecast maps, and flood alerts

- Review existing capabilities and determine areas of need for increased warning time
- Prioritize areas and determine options for increased forecasting abilities
- Secure funding and implement recommendations
- Provide updated information to appropriate response agencies

Convey flood height warnings from the USGS river gages in terms the general public can understand

- Review current warning information received from USGS
- Localize information to assist the public in understanding the warnings
- Provide messages to local media outlets explaining localized flood warnings

5.4 EMERGENCY RESPONSE AND RECOVERY

Utilize realistic training and exercises that simulate response conditions and scenarios for emergency responders, decision-makers, and general public.

- Determine needs for continued training
- Identify personnel that will benefit from training and exercises
- Coordinate trainings and vary topic to present new scenarios and response actions
- Utilize follow-up debriefing to allow for input on enhancements and/or lessons learned

Coordinate communications, documentation, and record keeping between NFIP communities and agencies including a database of accurate and specific information following each hazard event.

- Create a centralized reporting and documentation system to be utilized by each community and/or response agency
- Develop an SOP for tracking and reporting information
- Conduct a meeting or table-top exercise to present the centralized system and SOP

Develop and implement a voluntary immunization program for all emergency responders, inspection staff, and families

- Determine what immunizations are currently offered within each municipality
- Develop a listing of additional immunizations to be offered for municipal employees and family members
- Designate an agency to oversee the program and administer the immunizations

Designate snow routes to allow for snow removal activities

- Review current procedures for each municipality
- Develop routes based on access to critical facilities, large employers, or traffic patterns
- Provide route information to partnering response agencies
- Install signage if appropriate to inform the public of the need to keep areas clear during snow events

Develop an SOP for interactions and assistance between snow plows and response vehicles to clear paths during emergencies

- Determine needs of response agencies to ensure response
- Develop a SOP between Highway/Street Departments and Police/Fire/EMS which outlines activities to be undertaken prior to and during hazardous events
- Provide SOPs to proper response agencies and departments involved

5.5 FLOODPLAIN MANAGEMENT

Encourage restoration of the natural stream corridor in new and redevelopment projects

- Review current development codes and ordinances for new and redevelopment priority areas
- Provide opportunities for developers to use stream restoration techniques when planning new or redevelopment projects
- Create a stream restoration overlay zone within the ordinance

Conduct detailed hydraulic analyses of areas with repetitive flooding problems, unstudied, understudied, and unnumbered Zone A streams to determine floodplain boundaries.

- Review listing of unstudied streams and floodprone areas.
- Secure funding, municipal bond, or funds from existing budgets to complete floodplain studies.
- Update the Floodplain Prioritization Study to direct future analyses.

Support FEMA approved flood depth mapping (RiskMAP) to better understand the flood risk potential.

- Prioritize areas of greatest potential impact from flooding.
- Review effective floodplain boundaries.

- Secure funding and prepare a depth map to indicate the flood risk potential as a depth of water in affected areas.
- Inform land and property owners of the potential risk to their property and structures.

Create fluvial erosion hazard mapping to identify critical infrastructure that may be impacted by natural stream movement

- Review current floodplain maps and historical maps to determine areas of natural stream movement over time
- Develop listing of critical infrastructure that may be impacted from natural stream movement
- Incorporate hazard area into long range planning and zoning ordinances
- Develop recommendations to protect existing critical infrastructure within the hazard area

5.6 GEOGRAPHIC INFORMATION SYSTEMS

Update and coordinate GIS layers with location and attributes of critical infrastructure.

- Review current GIS layers and attribute information
- Include additional data as obtained relative to each critical infrastructure
- Coordinate access to layers for each community within the County

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.

- Determine GIS staff familiarity with HAZUS-MH
- Determine appropriate staff and provide opportunities for basic HAZUS-MH training as needed
- Utilize results in planning efforts and hazard training events

Update HAZUS-MH Earthquake model with local soil data for more accurate damage estimates

- Obtain most accurate soils data for Montgomery County
- Upload information into HAZUS-MH and run scenarios
- Determine if localized data provides varying results

5.7 HAZARDOUS MATERIALS RESPONSE TEAM

Maintain LEPC reporting and training efforts as required through SARA Title III and ensure current facility maps and response plans are on file for Tier II facilities.

- Ensure reports and training exercises are completed as required.
- Prepare listing of all Tier II facilities within Montgomery County.
- Obtain facility maps and response plans

Increase number of personnel certified to OSHA III Technician level

- Determine current number of each level of OSHA training.
- Identify current personnel suited for increased training
- Obtain training for those staff as available

5.8 LAND USE PLANNING AND ZONING

Incorporate hazard information, risk assessment, and hazard mitigation practices into the Comprehensive Land Use Plan and development review to better guide future growth and development.

- Draft language and prepare exhibits to incorporate into the appropriate sections of the Montgomery County Comprehensive Land Use Plan, individual excluded cities' plans, neighborhood redevelopment plans, etc.
- Adopt amendments as appropriate

5.9 MANAGEMENT OF HIGH HAZARD DAMS

Complete an IEAP annual exercise for existing and new high hazard dams.

- Review the IEAP and inundation mapping to better understand the hazard and associated risk
- Prepare the exercise to provide training to appropriate planning and response agencies within the area.
- Partner with the dam owner and IDNR to provide outreach materials to property owners within the inundation area.

Review regular inspection reports and maintenance records of high hazard dams

- Coordinate with high hazard dam owners and IDNR to receive copies of regular inspection reports and maintenance records

- Continue coordination and collaboration to ensure inspections are completed, the dam and surrounding area is maintained, and risks are assessed accordingly

5.10 POWER BACK-UP GENERATORS

Inventory presence of generators at critical infrastructure (and fuel capacity)

- Utilize listing of critical infrastructure and coordinate with facility owners or operators
- Determine presence or absence of generator, fuel capacity, and fuel reserve
- Determine if additional needs are required to ensure compatibility with generator (wiring)
- Secure or allocate funding to make necessary purchases or facility adjustments for generator

Secure a fuel reserve to ensure critical infrastructure are able to operate on generators for extended periods of time

- Utilize inventory and fuel capacity to determine overall fuel needs
- Coordinate with current municipal fuel providers
- Develop agreements for fuel provisions during and following hazard events

5.11PUBLIC EDUCATION AND OUTREACH

Post information and/or warning signage in local parks and other public gathering locations explaining outdoor warning sirens and local radio stations that carry emergency information.

- Identify areas where large gatherings may occur
- Prioritize areas identified
- Post information or signage as appropriate for each location

Develop an education and outreach campaign encouraging residents to keep in contact with their neighbors during hazard events

- Utilize CERT contacts and review locational areas of need
- Coordinate with residents to name a liaison for each area
- Provide training and educational materials to local liaison for distribution throughout the area

5.12SAFE ROOMS AND COMMUNITY SHELTERS

Inventory areas of need and work to establish safer rooms and community shelters in vulnerable locations (mobile home parks, critical facilities, developments without basements)

- Inventory vulnerable locations or populations without access to a safe room, community shelter, or a safer location
- Prioritize findings based on factors such as number or people, location, or health concerns
- Collaborate with private property owners to establish safer areas in those facilities
- Secure or allocate funding to establish safer areas in public facilities

5.13STORMWATER MANAGEMENT

Minimize the impacts of flooding by diverting or retaining stormwater onsite using green infrastructure practices

- Investigate and prioritize areas prone to flooding
- Determine the feasibility of incorporating green infrastructure practices on an individual site or regional scale
- Encourage landowners to install the practices or to allow a demonstration project on their property

Maintain channels and regulated drains to prevent localized flooding

- Review and assess information from the Surveyor's Office related to areas in need of maintenance
- Prioritize channels and drains based on flooding impacts or potential impacts
- Allocate funding and perform needed maintenance as feasible

Address flooding in low lying and urban areas due to poor drainage

- Assess areas experiencing routine flooding either due to low lying or poor drainage conditions
- Prioritize areas based on flooding impacts or potential impacts
- Allocate funding and implement recommendations as feasible

5.14TRANSPORTATION

Reduce the number of railroad/street crossings throughout Montgomery County

- Review current crossings and assess for feasibility of removing or altering the intersection
- Prioritize crossings and recommendations based on studies
- Collaborate with CSX (or other rail companies) and municipal agencies
- Secure or allocate funding and implement recommendations as feasible

5.15TREE MAINTENANCE

Maintain trees on public property and right-of-ways to encourage maintenance on private property to reduce the risk of downed utility lines and falling limbs

- Prioritize areas in need of maintenance (based on number of structures serviced, presence of larger trees, etc.)
- Perform routine preventative maintenance as funding and staffing allow
- Provide “Right Tree, Right Place” educational materials to landowners and residents in areas of above ground power lines

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 Montgomery 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 NFIP community. Depending on grant opportunities and fiscal resources, mitigation practices may be implemented independently, by individual NFIP 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 Montgomery County MHMP.

The EMA Director will reconvene the MHMP Committee on an annual basis and follow 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 9** 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 5 years (from the date of FEMA approval) to continue to be eligible for mitigation project grant funding. In early 2021, 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 Montgomery 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 Montgomery 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 to be made to each NFIP communities' planning documents and ordinances during the regularly scheduled update. Among other things, local planning documents and ordinances may include comprehensive plans, floodplain management plans, zoning ordinances, building codes, site development regulations, or permits. Modifications include discussions related to hazardous material facility buffers, floodplain areas, and discouraging development of new critical infrastructure in known hazard areas.

Based on added language within each of the Comprehensive Plan updates the appropriate Zoning Ordinances and Floodplain Management Ordinances within each community would also need to be amended.

6.3 CONTINUED PUBLIC INOLVEMENT

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

Continued public involvement is critical to the successful implementation of the Montgomery 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 Montgomery County website.

Updates or modifications to the Montgomery 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.

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