2015

MULTI-HAZARD MITIGATION PLAN

Adopted by:
Battle Ground, Clarks Hill, Dayton, Lafayette, Shadeland, Tippecanoe County, and West Lafayette

AREA PLAN COMMISION

The Multi-Hazard Mitigation Plan (MHMP) and its update represent a joint effort by the staffs of the Area Plan Commission, the Tippecanoe County Emergency Management Agency and the Planning Committee. This plan is a Multijurisdictional plan for Tippecanoe County, Lafayette, West Lafayette, Battle Ground, Dayton, Clarks Hill and Shadeland.

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TIPPECANOE COUNTY AREA PLAN COMMISSION

This Plan was prepared for Tippecanoe County, its member jurisdictions: Battle Ground, Clarks Hill, Dayton, Lafayette, Unincorporated Tippecanoe County, and West Lafayette; and Shadeland by the Area Plan Commission of Tippecanoe County staff led by Executive Director Sallie Fahey, Larry Aukerman, CFM and Bianca Zaklikowski with assistance and cooperation from the Tippecanoe County Emergency Management Agency, the Planning Committee and the POLIS Center. The Area Plan Commission extends a special thank you to members of the public who participated in the disaster survey and public meeting.

Members' jurisdiction meetings and adoption dates and resolution numbers:

Battle Ground	March 14, 2016- Resolution #16-69;
Clarks Hill	April 4, 2016- Resolution #2016-04-04
Dayton	April 4, 2016- Resolution #2016-1
Lafayette	March 7, 2016- Resolution #2016-05
Shadeland	March 8, 2016- Resolution #2016-3
Tippecanoe County	March 7, 2016- Resolution #2016-10-CM
West Lafayette	March 8, 2016- Resolution #05-16

This document was recorded in the Office of the Tippecanoe County Recorder on April 13, 2016,

I affirm under the penalties for perjury, that I have taken reasonable care to redact each social security number in this document, unless required by law. Prepared by Larry Aukerman of the Area Plan Commission

Sallie Dell Fahey

Sallie Dell Fahey, Executive Director, Area Plan Commission

as an amendment to the Comprehensive Plan for Tippecanoe County originally recorded in the Office of the Tippecanoe County Recorder as
Record Number Misc. 81, Page 434, on 23 October 1981.

MICHELLE L D'ANDREA-HALL
Tippecanoe County
NOTARY PUBLIC
Comm. # 666303
NOTARY SEAL
My Commission Expires 04-06-2023
STATE OF INDIANA

State of Indiana, County of Tippecanoe
Subscribed and sworn to before me this 13 day of April, 2016

Michelle L D'Andrea-Hall Notary Public Residing in
Tippecanoe County; My Commission Expires 4/6/23

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EXECUTIVE SUMMARY OF THE MULTI-HAZARD MITIGATION & FLOOD MITIGATION ASSISTANCE PLAN
2015 UPDATE

The Multi-Hazard Mitigation Plan (MHMP) and its update represent a joint effort by the staffs of the Area Plan Commission and the Tippecanoe County Emergency Management Agency and the Planning Committee. The Update has been reviewed by the Area Plan Commission, City of Lafayette, City of West Lafayette, Town of Battle Ground, Town of Clarks Hill, Town of Dayton, Town of Shadeland, representatives of Purdue University, and the public.

IMPLEMENTATION AND FUNDING

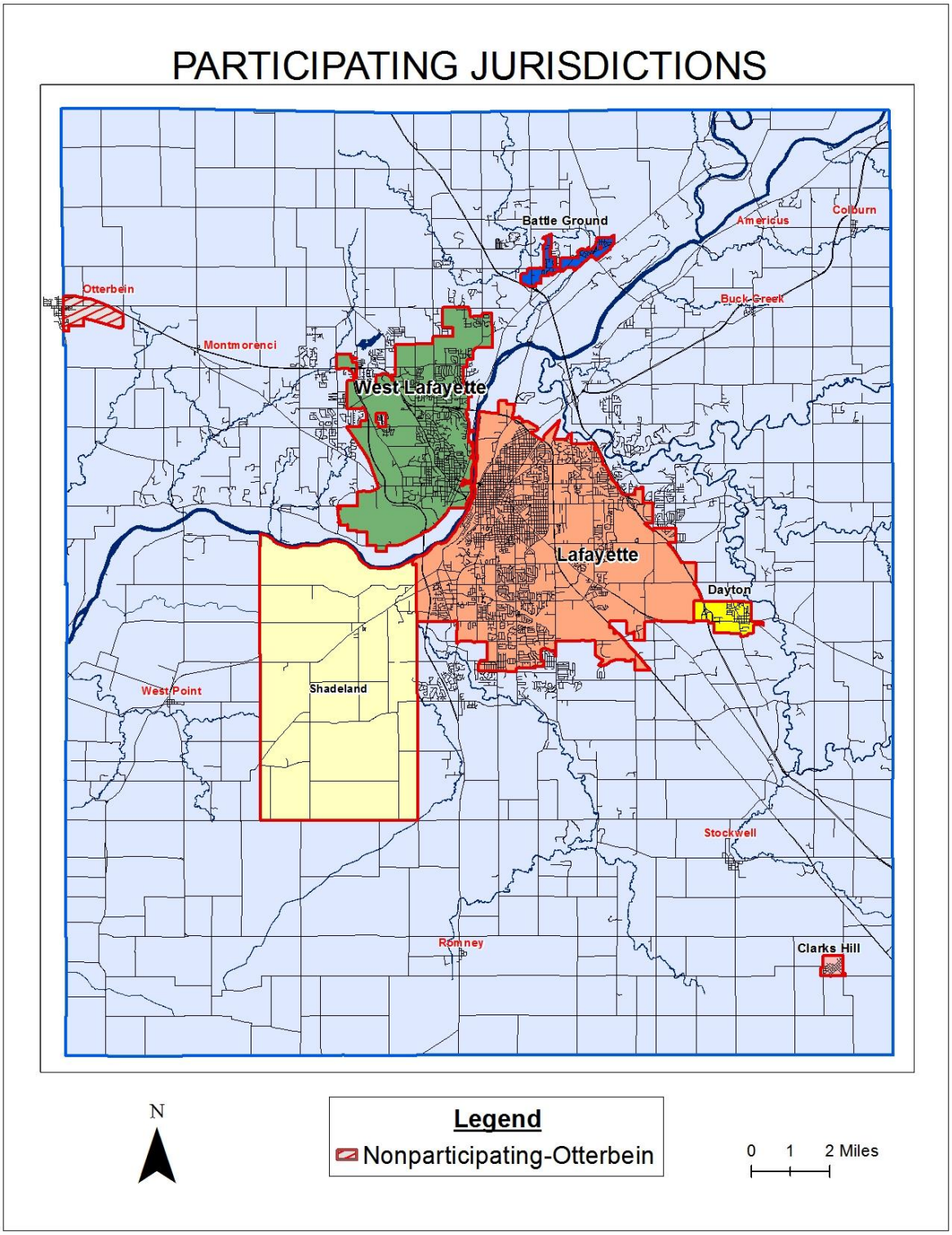
Adoption of this plan and required updates ensure that the communities involved will be eligible for future federal disaster assistance as well as federal buyout money. It also enables the communities to apply for a variety of grants, such as Hazard Mitigation Grants (HMG), to implement projects to reduce damages. Some projects are easier to implement than others, because the cost can be absorbed in staff time. These include ordinance amendments, database management and public education. Other projects, such as watershed studies, the flood buyout program and purchasing additional outdoor warning sirens require grant money.

HAZUS
HAZUS is a nationally applicable standard methodology that models for estimating potential losses from earthquakes and floods. HAZUS uses GIS data to estimate impacts of disasters. HAZUS is used in mitigation planning and preparedness.

The Multi-Hazard Mitigation Plan provides a comprehensive assessment of how specific hazards affect the community and proposes solutions to prevent future damage caused by natural and manmade hazards. It will also be used as a tool in future planning to assist community leaders, government departments and citizens to make informed decisions regarding land use, transportation and emergency management. Annual reviews will assess implementation progress and the success of mitigation strategies. Periodic updates will keep the plan current, provide new opportunities for innovative thinking, and allow for inclusion of additional mitigation projects.

Hazard Mitigation
"Hazard mitigation is sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects" fema.gov

Exhibit 1 Geographical area covered by this plan



1.0 INTRODUCTION

1.1 DISASTER LIFE CYCLE

The Federal Emergency Management Agency (FEMA) defines the disaster life cycle as the process through which the community and emergency managers respond to disasters when they occur, recovery from disasters, reducing the risk of future losses and preparedness for emergencies and disasters.

The disaster life cycle includes 4 phases:

- **Response** – the mobilization of the necessary emergency service and first responders to the disaster area
- **Recovery** – to restore the affected area to its previous state; includes rebuilding, re-employment, repair of infrastructure
- **Mitigation** – to prevent or reduce the effects of disasters through building codes, zoning, vulnerability analyses and public education
- **Preparedness** – planning, organizing, training, equipping, exercising, and evaluation and improvement activities to ensure the effective coordination and the enhancement of preparedness plans, emergency exercises, training and warning systems.

The Tippecanoe County Multi-Hazard Mitigation Plan (MHMP) focuses on the mitigation phase of the disaster life cycle. According to FEMA, mitigation is sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects. 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 reduce the social, physical and economic impact of the hazards.

1.2 PROJECT SCOPE AND PURPOSE

The development and update of a community Multi-Hazard Mitigation Plan (MHMP) is a requirement of the Federal Disaster Act of 2000 (DMA 2000) and §201.6(d)(3)**: "*A local jurisdiction must review and revise this plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities, and resubmit it for***

approval within five years in order to continue to be eligible for mitigation project grant funding."

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. This planning effort also includes Clarks Hill, a non-NFIP participating community. This community should enter the NFIP program as well as adopt established mitigation plans. The Indiana Department of Homeland Security (IDHS) and the Federal Emergency Management Agency (FEMA) Region V offices administer the MHMP program in Indiana. Historically, planning in Tippecanoe County has been accomplished by the Area Plan Commission for its participating jurisdictions; the same is true for this effort.

Development and update of this MHMP is necessary in a series of implementation, policy creation and projects to mitigate adverse effects of hazards in Tippecanoe County. The purpose of this planning effort is to identify hazards and to what extent they affect the residents of the county as well as to determine what type of mitigation strategies, goals or projects may be implemented for mitigating hazards. Although this MHMP update meets the requirements of DMA 2000 and eligibility requirements of the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA), Pre-Disaster Mitigation (PDM) Grant, as well as other FEMA programs including the NFIP Community Ratings System (CRS), additional detailed studies may need to be completed prior to applying for grants and/or programs.

NFIP/CRS Throughout the Plan, activities that could qualify for 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 requirements of the NFIP. As a result, flood insurance premium rates are discounted to reflect reduced flood risk from community actions that meet the three goals of the CRS program: 1) reduce flood losses; 2) facilitate accurate insurance ratings; and 3) promote education and awareness of flood insurance. Savings in flood insurance premiums are proportional to the points assigned to different mitigation efforts. A minimum of 500 points is necessary to enter the CRS program, which would result in a 5% flood insurance premium discount. Currently, no community in Tippecanoe County participates in the program and one of our communities, Clarks Hill, is not an NFIP

member. An on-going goal of this plan is full-community participation in the CRS program.

In December of 2014 Tippecanoe County was awarded a grant for technical assistance. The grant was awarded to the Polis Center. The Polis Center performed HAZUS Modeling for Tornado, Flooding, Earthquake, and Hazardous Materials Release events. The Polis Center also provided review and guidance in FEMA compliance submittals. The results of their analyses are included as an index in this plan.

Funding for this project was provided by the Area Plan Commission of Tippecanoe County and the Indiana Department of Homeland Security.

1.3 THE PLANNING PROCESS

1.3.1 PLANNING COMMITTEE

The Area Plan Commission of Tippecanoe County is leading the multi-jurisdictional planning effort in collaboration with the Tippecanoe County Emergency Management Agency (TEMA). The plan update was prepared in partnership with Tippecanoe County, the City of Lafayette, and the City of West Lafayette along with the Towns of Battle Ground, Dayton, Shadeland and Clarks Hill. Representatives from these communities attended planning committee meetings, provided valuable information about their communities, reviewed and commented on the draft plan and held hearings to adopt the plan. Each community had an equal opportunity for participation and representation in the planning process. The process used to develop the Tippecanoe County MHMP and its update satisfies the requirements of a DMA 2000 multi-jurisdictional plan which provides that a plan may be accepted as long as each jurisdiction has participated in the planning process. §201.6(c)(1) states ***"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."***

The Town of Otterbein straddles Benton and Tippecanoe Counties; the town falls under the jurisdiction of Benton County Emergency Management and was not part of this process. The Town of Shadeland is not a member of the Area Plan Commission but is participating in this plan.

In September 2014, a first draft update to the Tippecanoe County Multi-Hazard Mitigation Plan was distributed to the Planning Committee for review and comment. Staff incorporated feedback, held an additional meeting, included updated public survey information and a public meeting was held on July 15, 2015. The second draft of the Plan was made available prior to this meeting, on the county's website and by providing the draft version for review by local agencies involved in hazard mitigation and participating jurisdictions.

After public review, comments were incorporated into the draft plan which was then forwarded to IDHS and FEMA for their review. Comments obtained from IDHS and FEMA were reviewed by staff and incorporated into the plan filed for adoption. Local adoption of the MHMP by Tippecanoe County, the City of Lafayette, the City of West Lafayette, the Town of Battle Ground, the Town of Dayton, the Town of Clarks Hill and the Town of Shadeland was completed in 015 (specific adoption dates can be found on the title page).

The Tippecanoe County MHMP Planning Committee was created specifically to review this plan and provide new information for its update. The membership of this committee included representatives from various county offices, the City of Lafayette, the City of West Lafayette, the Town of Battle Ground, the Town of Dayton, the Town of Clarks Hill and the Town of Shadeland, all of whom have responsibility for disaster mitigation efforts in their respective jurisdictions. The Planning Committee also included representatives from emergency response agencies including the TEMA Director and representatives from local fire, police and sheriff's departments as well as Purdue University, non-profit groups, public works, zoning and planning, parks and recreation and local citizen representatives.

The Planning Committee met 5 times in March and June 2011 and June 2014. The meetings were held at the Community Corrections Building because there was ample meeting space at a neutral location, as well as being the recently completed Emergency Operations Center (EOC) at 629 N. 6th Street. The meetings were well-attended and lasted approximately one hour each. The Committee discussed and made decisions on the information presented by APC staff. During the meetings, the committee successfully identified critical facilities that were constructed since the adoption of the 2005 plan; decided on the severity and likelihood of local disasters; reviewed local mitigation goals and any progress that had been made on the goals set in 2005 and set new mitigation goals. Each member present signed in at the meetings in order to

document participation. Meeting agendas and summaries are included in **Appendix A.** Several members of the Planning Committee attended the public hearing in October 2014 and assisted with the adoption of the Tippecanoe County MHMP Update in each of their jurisdictions. **Table 1-1** is a list of all committee members.

Exhibit 2 Planning Committee

Table 1-1: MHMP 2014 Planning Committee		
Name	**Title**	**Representing**
Sallie Fahey	Executive Director	Tippecanoe County APC
Larry Aukerman	Planner, CFM	Tippecanoe County APC
Kathy Lind	Senior Planner	Tippecanoe County APC
Ryan O'Gara	Assistant Director	Tippecanoe County APC
Smokey Anderson	Director	TEMA
Marty Webb	Technician	TEMA
Dave Byers	Commissioner	Tippecanoe County
Laurie Wilson	Grant Coordinator	Tippecanoe County
Mark Ehle	GIS Coordinator	Tippecanoe County
Ryan Tennessen	Emerg. Preparedness Coord.	Tippecanoe County
Ken Brown	Building Commissioner	Tippecanoe County Building Commission
Mike Spencer	Assistant Executive Director	Tippecanoe County Highway
Zach Beasley	Surveyor	Tippecanoe County Surveyor
Charlie Williams	Major	Tippecanoe County Sheriff
Jim Butcher	Project Manager	Tippecanoe County Surveyor
David Downey	Street Commissioner	City of West Lafayette
Rick Doyle	Fire Chief	City of Lafayette
Mike Francis	Captain	West Lafayette Police Department
Mike Blann	Assistant Chief of Special Operations	Lafayette Fire Department

Table 1-1: MHMP 2014 Planning Committee		
Name	**Title**	**Representing**
Carol Shelby	Senior Director Environmental Health & Safety	Purdue University
Emma York	Manager Safety, Health, and Security	Evonik Industries
Heather Philhower	Representative	American Suburban Utilities
Larry Heil	Environmental Specialist	Federal Highway Administration
Stan Lambert	Director	Wabash River Enhancement Corporation
Donna Majewski	Representative	LEPC
Steve Cain	Disaster Communications Specialist	Purdue
Jim Hawley	Former Executive Director	Tipp Co. APC/Citizen

Planning Committee Members

These members provided helpful insights and input into the first update in 2011, but no longer served in the same capacities in 2014:

Ron Highland, Tippecanoe County Building Commissioner
Tilara Treece, Health Coordinator Tippecanoe County Health Department
Tom Rankin, Security Director Lafayette Parks Department
Ted Bumbleburg, Superintendent Lafayette Parks Department
Brian Bugajski, Project Manager City of Lafayette
Bob Wollenberg, Director American Red Cross
Christine Brady, EMS Director American Red Cross
Tim Rytlewski, Mgr. Support Operations Evonik
Charlie Hoovler, Citizen

1.3.2 PUBLIC INVOLVEMENT IN THE PLANNING PROCESS

The planning process to prepare the Tippecanoe County MHMP update began in February 2011. A Planning Committee was formed using guidelines from the 2005 MHMP and requirements of DMA 2000. In March 2011, June 2011, June 2014, and July 2015 the Planning Committee met to review any relevant changes to the plan including

new hazard data, updating critical facilities and providing information about community projects and on-going mitigation efforts. In August, a community survey for public input was added to the Area Plan Commission's web site.

In September 2011 and again in July 2015, staff distributed to the Journal and Courier, the Purdue Exponent, the Lafayette Leader, and local radio stations including Shine 99, WBAA, WASK, WAZY, WGLM and WKHY and the local CBS television station (WLFI) a media release titled "How do tornadoes, floods, and severe winter storms affect you?" It also identified communities participating in the MHMP update effort, requirements of DMA 2000 and included information about the upcoming on-line survey to which interested residents could respond.

Based on public response to the survey, residents consider winter snow storms to be most likely to impact our area with 40% of the respondents indicating that winter storms were very likely to occur in Tippecanoe County. Additionally, the survey revealed that 95% of respondents had experienced a snow storm in Tippecanoe County followed by ice storms at 62% of respondents. Complete survey results can be found in **Appendix B**. A list of the different media that were contacted can be found in **Appendix C** as well as the September 2011 and October 2014 media release.

1.3.3 NEIGHBORING COMMUNITY INVOLVEMENT

The planning team invited participation from neighboring counties to obtain their involvement in the draft plans. A draft copy of the plan was sent to the following counties. Details of neighboring stakeholders' involvement are summarized in the exhibit below.

Exhibit 3 Neighboring Community

Participant Name	Neighboring County/Community	Organization	Participation Description
Robert Yerk	White County, IN	White County EMA	Received a draft of plan for review; no revisions
Phil Astell	Warren County, IN	Warren County EMA	Received a draft of plan for review; no revisions
John Fields	Benton County, IN	Benton County EMA	Received a draft of plan for review; no revisions
Dana Jefferies	Carroll County, IN	Carroll County EMA	Received a draft of plan for review; no revisions
Darrell Sanders	Clinton County, IN	Clinton County EMA	Received a draft of plan for review; no revisions

Shari Harrington	Montgomery County, IN	Montgomery County EMA	Received a draft of plan for review; no revisions
Joe Whitaker	Fountain County, IN	Fountain County EMA	Received a draft of plan for review; no revisions

1.4 PLANS, STUDIES, REPORTS AND TECHNICAL INFORMATION

During the development of the Tippecanoe County MHMP Update, several relevant sources of information were reviewed. This exercise was completed to gather updated information since the development of the original MHMP and to assist the planning committee in developing potential mitigation measures to reduce the social, physical and economic losses associated with hazards affecting Tippecanoe County. This meets the FEMA requirement of §201.6(c)(1): ***The plan shall include a review and incorporation, if appropriate, of existing plans, studies, reports and technical information.***

For the purposes of this planning effort, the following materials were utilized:

- Tippecanoe County Comprehensive Plan (1981)
- Lafayette Parks and Recreation Plan
- *The Lafayette Journal and Courier* (archived and current articles)
- Tippecanoe County Flood Insurance Rate Maps
- Tippecanoe County Hazardous Commodity Study (2012)

NFIP/CRS 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 with other agencies and departments to resolve common problems related to flooding and other known natural hazards.

2.0 COMMUNITY INFORMATION

Although much of the information within this section is not required by DMA 2000, it is important background and perspective about the history, physical, social and economic

composition of Tippecanoe County necessary to understand the Risk Assessment described in **Chapter 3**.

Tippecanoe County was established in 1826. Located in west central Indiana, its area is 503.24 square miles, 3.44 square miles of which are water. The county seat is Lafayette, located near the middle of the county along the Wabash River.

2.1 TOPOGRAPHY

The topography and geography of Tippecanoe County has been greatly influenced by glaciations; alluvial action can be found on level glacial till plains eroded by stream valleys. The county covers an area of approximately 502 square miles and the major physiographic feature is the Wabash River. The River runs diagonally through the county from the northeast to the southwest, exiting near the center of the county's western boundary. There are two main tributaries to the Wabash River: the Tippecanoe River and Wildcat Creek. The Tippecanoe River enters the county from the north and is approximately 5.5 miles in length before its confluence with the Wabash River. There are two hydroelectric upstream damns on the Tippecanoe River in Carroll and White Counties. Wildcat Creek has three branches in all; two of which are state designated scenic rivers. All of the branches merge before emptying into the Wabash near the center of the county.

The county slopes gently to the southwest and lies entirely within the drainage basin of the Wabash River. The greatest changes in elevation in the county naturally occur along the river valleys. The uplands lie approximately 700 feet above mean sea level (MSL), while elevations along the Wabash River range from 500′ MSL to 510′ MSL. The highest elevation is 833′ near the southeastern corner of the county and the lowest elevation, 500′, can be found where the Wabash River exits the county along the western county line.

2.2 CLIMATE

Based on information from the State Climatologist's Office, the annual mean temperature in Tippecanoe County is 51º Fahrenheit. Historic extreme temperatures have ranged from -25ºF in 1994 to 105º F in 1983. The county experiences an annual average rainfall of 38.91 inches per year and an annual average snowfall of 22 inches. The driest month is typically February with 1.58 inches of precipitation and the wettest is June with 4.24 inches. The summer of 2012 was one of the driest on record, with most

of the state under extreme to severe drought conditions. According to NOAA, Lafayette was 3 inches below normal precipitation levels in July. July, 2012 also set temperature records as Lafayette experienced 7 days over 100 degrees.

2.3 DEMOGRAPHICS

Population data, available from the 2010 Census, indicates a total population in Tippecanoe County of 172,780. **Table 2-1** outlines additional population data.

Exhibit 4 Population Data

Table 2-1: 2010 Tippecanoe County Population Data	
NFIP Community	**Population**
Tippecanoe County (total)	172,780
US Census 2013 Estimate	180,174
City of Lafayette	67,140
City of West Lafayette	41,894**
Town of Battle Ground	1,334
Town of Dayton	1,420
Town of Shadeland	1,610
Non-NFIP Community	
Town of Clarks Hill	611

**Based on the 2014 Census Certification after annexation

The majority of Tippecanoe County residents, 63.1% fall into the 18-65 age range with a median age of 27.7

2.4 ECONOMY

According to the US Census, the median household income in 2012 was $44,047. Tippecanoe County has long served as an employment and retail hub for an area of seven surrounding counties. This is evidenced by 18,414 workers who commute into Tippecanoe County for employment based on Indiana workers' tax returns. The county from which most workers come into Tippecanoe is Carroll County with over 2700 employees making the commute.

Data from the Indiana Department of Workforce Development shows the workforce in Tippecanoe County totaled 95,601 people; with the unemployment rate in September 2014 of 7.3%. The county has also historically seen high education rates with 89.5% of adults having at least a high school diploma and 34% of those with a Bachelor's Degree or higher.

2.5 INDUSTRY

The largest employment sectors in Tippecanoe County are government, employing 24% of workers, manufacturing at 12.8% and health care and social services with 11.2% of the workforce population (BEA, 2009). Purdue University is the largest employer in the county with over 15,000 employees followed by Subaru of Indiana Automotive with 3,273.

The Lafayette area is home to several industrial expansions and new investments in the last several years. Nanshan America opened a new 600,000 sq.ft. aluminum extrusion plant in 2012, employing 150. Additionally, GE Aviation is slated to open an assembly plant to manufacture its new Leap engines, employing over 200 in 2015.

New industry has located in Tippecanoe County in the last five years including Nanshan Aluminum as well as DowAgro Sciences in Purdue's Research Park. Green energy is on the industrial radar as well with the future construction of the Purdue Energy Park Wind Farm. In 2009, construction of the new Indiana Clarian Arnett Hospital began and St. Elizabeth East opened in 2010, consolidating a majority of functions from the former St. Elizabeth site (now St. Elizabeth Central) and former Home Hospital (now razed and redeveloped as residences for seniors).

2.6 LAND USE AND DEVELOPMENT TRENDS

Tippecanoe County has experienced steady growth, in both population and employment since the late 1980's/early 1990's when Subaru International Automotive plant and Wabash National semi-trailer plant located and began operations here. Residential growth as a factor of industrial expansion continues to be evidenced in the number of single-family home building permits. The county, much like the rest of the country, went through a period of stagnation and decline in the mid-2000s; in 2010, there were only 381 new single-family homes built in Tippecanoe County. That number has slowly risen as building and the economy has picked up: 454 single-family home permits were issued in 2014.

New residential development has been concentrated on the south and east sides of Lafayette and north and northwest sides of West Lafayette. Several new elementary schools have been built and expanded, further reflecting Tippecanoe County's residential growth. Battle Ground Middle School in the northern part of the county, just

outside of West Lafayette was finished in 2007. On the south side of the county, Woodland Elementary school was completed in 2007 and Wea Ridge Elementary received an 18,000 sq. ft. addition that opened in summer 2014.

Since the last plan, 672 multi-family units have been platted as well as 742 single-family lots spanning the area from Downtown Lafayette to west of West Lafayette down to the south edge of Lafayette's city limits.

An area for future industrial expansion is reserved on the southeastern side of Lafayette; some of the land is in the unincorporated county, but will be served by sanitary sewer and water from Lafayette. The Purdue Research Park on West Lafayette's north side has additional room for expansion on both the north and south sides of Kalberer Road.

Several recent Tax Increment Finance Districts have been created to further investment and infrastructure development in targeted areas of the county.

2.7 RIVERS AND WATERSHEDS

According to the Indiana Department of Environmental Management (IDEM), there are 65 waterways in Tippecanoe County. **Table 2-2** lists the waterways identified. All of the county's waterways drain into the Wabash River.

Exhibit 5 Waterways

Table 2-2 : List of Waterways		
Anderson Ditch	Bee Run	Big Shawnee Creek
Blickenstaff Ditch	Bowers Creek	Box Ditch
Bridge Creek	Brown Ditch	Buck Creek
Buck Creek Ditch	Burnett Creek	Coffee Run Creek
Cole Ditch	Darby Ditch	Dismal Creek
Dry Run	Durkee Creek	E. Branch Big Wea
East Branch Wea Creek	Edward Ditch	Elliott Ditch
Flint Creek	Flint Run	Goose Creek
Harrison Creek	Haywood Ditch	Hentz Ditch
Hoffman Ditch	Hog Run	Ilgenfritz Ditch
Indian Creek	Jordan Creek	Kellerman Lea Ming Ditch
Lauramie Creek	Little Flint Creek	Little Pine Creek
Little Sugar Creek	Little Wea Creek	Lofland Ditch
Lost Creek	Marshall Ditch	McFarland Ditch
McKinney Ditch	Montgomery Ditch	Middle Fork Wildcat Creek

Moots Creek	Moses Baker Ditch	North Fork Wildcat Creek
North Fork Burnett Creek	O'Neall Ditch	South Fork Wildcat Creek
Otterbein Ditch	Philip Dewey Ditch	Platt Ditch
Resser Ditch	Romney Fraley Ditch	Southworth Branch
Stock Farm Ditch	Stoddard Ditch	Sugar Creek
Tippecanoe River	Wabash River	Wallace Ditch
Walters Ditch	Wea Creek	

According to IDEM, there are 47 Hydrologic Unit Code (HUC) watersheds in Tippecanoe County. Table 2-3 lists the identified watersheds.

Exhibit 6 Watersheds

Table 2-3: List of 14-Digit HUC Watersheds

14-Digit HUC#	14-Digit HUC NAME	Total Acres
05120106150050	Tippecanoe River-Main Stem	10754.1
05120106150060	Rayman Ditch/Myers Ditch	13230.7
05120105060010	Wabash River-Bowen Ditch	6854.6
05120106150080	Moots Creek-Tippecanoe River Outlet	12325.5
05120108040070	Big Pine Creek-Brumm Ditch	11022.9
05120108010020	North Fork Burnett Creek-Brown Ditch	11598.2
05120108010010	Burnett Creek-Headwaters	16772.5
05120105060020	Wabash River-Bridge Creek	8218.5
05120108040080	Big Pine Creek-Darby Ditch	11773.2
05120108010030	Burnett Creek-Wabash R Bottoms	6573.8
05120108030020	Indian Creek (Tippecanoe)	18960.6
05120108030060	Little Pine Creek-McFarland/Otterbein Ditches	13175.2
05120105070030	Wabash River-Harrison Creek	5114.6
05120105070010	Sugar Creek-Little Sugar Creek (Tippecanoe)	18360.6
05120105070020	Buck Creek (Tippecanoe)	7495
05120107020100	Wildcat Creek-Pyrmont	14949.1
05120107050010	Wildcat Creek-Dry Run	8994.8
05120108010040	Wabash River-Lafayette	14088.1
05120108030070	Little Pine Creek-Armstrong Creek	13404.4
05120108030010	Wabash River-Jordan Creek	10027.6
05120107030070	Middle Fork Wildcat Creek-Pettit	6768.9
05120107040140	South Fork Wildcat Creek-Cary Camp	4524.4
05120107030060	Middle Fork Wildcat Creek-Hog Run	12877
05120107040130	South Fork Wildcat Creek-Dayton	14307.6
05120108020070	Elliot Ditch	11886.8
05120108030030	Wabash River-Lost Creek	16841.3
05120108020090	Wea Creek-Outlet	3009.3
05120108030050	Wabash River-Flint Creek/Grindstone Creek	15242.6

Table 2-3: List of 14-Digit HUC Watersheds		
14-Digit HUC#	**14-Digit HUC NAME**	**Total Acres**
05120108020080	Little Wea Creek	21379.7
05120108020060	Wea Creek-Kenny Ditch	15193.3
05120107040110	South Fork Wildcat Creek-Mulberry	13323.4
05120108030040	Flint Creek-Flint Run	13964.5
05120107040120	Lauramie Creek	15090.8
05120108070020	Shawnee Creek-Headwaters (Fountain)	23784.8
05120108020050	East Branch Wea Creek-Platt Ditch	7375
05120108020030	Wea Creek-Haywood/Kellerman Leaming Ditch	11279
05120108020040	East Branch Wea Creek-Headwaters	10982.5
05120108070030	Shawnee Creek-Kell Dt/Little Shawnee	17382.7
05120108020020	Romney Fraley Ditch	8782
05120110030030	Bowers Creek	11919.6
05120108020010	Lofland Ditch-Phillip Dewey/Stoddard Ditches	14588.3
05120108100020	North Fork Coal Creek-Lower	14704.5
Total		**518902**

2.8 CRITICAL FACILITIES

FEMA provides some guidance for selecting critical and non-critical facilities and describes some approaches to identifying those facilities. FEMA's Public Assistance Guide (FEMA 322) states "Critical facilities are critical to the health and welfare of the population and that are especially important following hazard events. Critical facilities include, but are not limited to shelters, police and fire stations, and hospitals." The related regulation at 44 CFR 206.226, restoration of damaged facilities states that "eligible private nonprofit facilities may receive funding under the following conditions: the facility provides critical services which include power, water (including water provided by an irrigation organization or facility in accordance with 206.221(e)(3)), sewer services, wastewater treatment, communications, emergency medical care, fire department services, emergency rescue and nursing homes." Thus, critical facilities appear to fulfill important functions in maintaining community stability and living conditions.

The following list suggests some examples of potential critical facilities:

- Structures or facilities that produce, use or store highly volatile, flammable, explosive, toxic, and/or water-reactive materials;
- Hospitals, nursing homes and housing likely to have occupants who may not be sufficiently mobile to avoid injury or death during a hazard;

- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for flood response activities before, during and after a hazard; and
- Utility facilities that are vital to maintaining or restoring normal services to areas before, during and after a hazard.

The Planning Committee reviewed the critical facilities included in the 2006 Plan. Changes made to the list include noting which facilities had closed, moved or were newly constructed. The updated critical facility list includes two hundred and thirty-three (233) critical facilities in Tippecanoe County.

These facilities include 5 dams, 53 schools (including Purdue University and Ivy Tech State College), 10 public/private airports, 9 police stations (including 1 jail), 1 National Guard Facility, 23 fire stations, 20 nursing/veteran's/children's homes, 4 hospitals, 17 potable water facilities (including all of the City of Lafayette and the Indiana-American Water Company wells), 8 wastewater facilities, 5 bus/train stations, 10 broadcast facilities and 67 hazardous material facilities. **Exhibit 1** Illustrates the location of critical facilities and **Appendix D** lists the critical facilities by NFIP community.

Because this MHMP process focused on critical facilities, non-critical facilities are not mapped or listed. As envisioned in the 2006 MHMP, future updates of this plan will always include revisions to the critical facilities list. Airports, hazardous material handlers, communications towers, hospitals, schools, fire stations, nursing homes, and police stations are in the attached maps and have been updated as of 2014.

3.0 RISK ASSESSMENT

The goal of mitigation is to reduce future impacts of hazards on all areas of civil society, such as public and private property damage, disruption to local and regional economies, the amount of public and private funds spent to assist with recovery, and the displacement of a portion of the population. A community must complete a comprehensive examination of the risks associated with natural and manmade hazards to help establish and realize community mitigation goals. Risk assessment of hazards measures potential loss by assessing the vulnerability of buildings, infrastructures and community residents. It helps to identify characteristics of each hazard as well as potential consequences, such as what portion of the community will be affected and

how community assets will be impacted. A typical risk assessment has three components: hazard identification; risk analysis; and vulnerability analysis

Table 3-1 illustrates the hazards discussed and those the Planning Committee chose to study in depth. Hazards that were studied are shown in bold and include: earthquake, flood, severe winter storm (including ice), tornado, windstorm, hazardous materials (storage and transport) and utility failure (not weather related).

Exhibit 7 Hazards

Table 3-1: Hazards Discussed by the Planning Committee

List of Hazards	Hazards with Local Impact	Hazards for Detailed Study
Avalanche	No	
Coastal Erosion	No	
Coastal Storm	No	
Dam Failure	Yes	Yes
Drought	Yes	No
Earthquake	**Yes**	**Yes**
Expansive Soils	No	
Extreme Heat	Yes	No
Flood	**Yes**	**Yes**
Hailstorm	Yes	No
Hurricane	No	
Land Subsidence	No	
Landslide	No	
Severe Winter Storm (ice)	**Yes**	**Yes**
Tornado	**Yes**	**Yes**
Tsunami	No	
Volcano	No	
Wildfire	No	
Windstorm	**Yes**	**Yes**
Hazardous Materials (storage & transport)	**Yes**	**Yes**
Ebola Outbreak	**Yes**	**No**

Table 3-1: Hazards Discussed by the Planning Committee		
List of Hazards	**Hazards with Local Impact**	**Hazards for Detailed Study**
Utilities (gas, sewer, water, electricity)	**Yes**	**Yes**

Note: Hazards shown in bold were studied in detail.

After identifying hazards, the Planning Committee helped prioritize them by importance and potential for disruption to the community. A tool for prioritizing hazards is the Calculated Priority Risk Index (CPRI) adopted from MitigationPlan.com. The CPRI evaluates each hazard based on its probability of occurrence, severity, warning time and duration. This tool provides a means of assessing each hazard as compared to other hazards.

To determine the CPRI, a value of 1 through 4 is assigned to each of the following categories:

- probability (unlikely – highly likely);
- magnitude/severity (negligible – catastrophic);
- warning time (more than 24 hours – less than 6 hours); and
- duration of event (less than 6 hours – greater than 1 week).

The following formula calculates the CPRI value:

- CPRI = Probability X 0.45 + Magnitude/Severity X 0.30 + Warning Time X 0.15 + Duration of Event X 0.10

Exhibit 8 Risks

Table 3-2 summarizes the CPRI for all of the studied hazards in this planning effort.

Table 3-2: Calculated Priority Risk Index for Tippecanoe County					
	Probability • Unlikely • Possible • Likely • Highly likely	**Magnitude/ Severity** • Negligible • Limited • Critical • Catastrophic	**Warning Time** • >24 hrs • 12-24 hrs • 6-12 hrs • < 6 hrs	**Duration of Event** • < 6 hrs • <1 day • < 1 wk • > 1 wk	**CPRI**
Hazardous Materials	Highly Likely	Catastrophic	< 6 hrs	< 1 wk	3.9
Flooding	Highly Likely	Critical	< 6 hrs	> 1 wk	3.7
Tornado/Windstorm	Highly Likely	Catastrophic	< 6 hrs	< 6 hrs	3.7
Severe Winter Storm	Highly Likely	Critical	12-24 hrs	< 1wk	3.6
Earthquake	Highly Likely	Limited	< 6 hrs	< 6 hrs	3.1

Dam Failure	Possible	Critical	< 6 hrs	< 6 hrs	2.5
Utilities	Possible	Negligible	< 6 hrs	< 1 day	2.0

According to the CPRI, historical data and knowledge provided by local planning and emergency professionals, and committee members, the storage, transport, and spills of hazardous materials (3.9) ranked as the highest priority hazard for Tippecanoe County, followed by flooding (3.7), tornado/windstorm (3.7). The CPRI for severe winter storms increased from 3.3 in 2006 to 3.6 in 2011 and dam failure was lowered to a 2.5 CPRI score from 3.0 in 2006. Section 3.2 includes a profile of individual hazards as well as CPRI values for each community that participated in the planning process.

3.1 HAZARD IDENTIFICATION

The MHMP Planning Committee reviewed the hazards studied in the previous Plan: Hazardous Materials Spills, Floods, Tornadoes/Windstorms, Winter Storms, Earthquakes, and Dam and Utility Failure. The Committee agreed that hazardous chemical spills were a possibility, had little warning time and could have far reaching effects. Severe Winter Storms were determined to have catastrophic results, as opposed to severe (as determined in the 2006 Plan), and the Committee agreed to move the likelihood of Dam Failure to possible instead of likely. Factors for Utility Failure, Earthquakes, Floods and Tornadoes remained unchanged from the 2006 Plan.

The Planning Committee discussed hailstorms and drought and effects of severe heat because those events are both cyclical and seasonal and difficult to mitigate; hailstorms were considered with tornadoes and windstorms. The effects of nuclear hazards were briefly discussed because of Purdue's nuclear reactor, but were not studied because its size is very small.

3.1.1 GIS AND HAZUS-MH MODELING

FEMA's Pre-Disaster Mitigation (PDM) program is designed to provide assistance to local communities to develop and implement their hazard mitigation plan, thereby reducing risk to property and lives.

Existing Hazus-MH technology was used in the development of the vulnerability assessment for flooding and earthquakes. With the implementation of new technology and locally available parcel datasets, more accurate results are now available. Multi-

hazard mitigation plan updates may document significant variances from the original MHMP.

The flood and earthquake assessments are based on a Level 2 Hazus analysis. Hazus-MH generated a combination of site-specific (flood) and aggregated loss (earthquake) estimates. Aggregate inventory loss estimates, which include building stock analysis, are based upon the assumption that building stock is evenly distributed across census blocks/tracts. With this in mind, total losses tend to be more reliable over larger geographic areas than for individual census blocks/tracts. Site-specific analysis is based upon loss estimations for individual structures. For flooding, analysis of site-specific structures considers the depth of water in relation to the structure. Hazus-MH also considers the actual dollar exposure to the structure for the costs of building reconstruction, content, and inventory. Damages, however, are based upon the assumption that each structure will fall into a structural class, and structures in each class will respond in a similar fashion to a specific depth of flooding. Site-specific analysis is also based on a point location rather than a polygon; therefore the model does not account for the percentage of a building that is inundated.

It is important to note that Hazus-MH is not intended to be a substitute for detailed engineering studies. Rather, it is intended to serve as a planning aid for communities interested in assessing their risk to flood, earthquake, and hurricane-related hazards. This documentation does not provide full details on the processes and procedures completed in the development of this project. It is only intended to highlight the major steps that were followed during the project.

3.2 HAZARD PROFILE

3.2.1 HAZARDOUS MATERIALS

Storage, transportation and spills associated with hazardous materials are a concern to urban areas that have businesses which use or store chemicals and have major transportation routes, interstates or railways traversing through city and county boundaries. A hazardous material is any element, compound, or combination thereof which is flammable, corrosive, detonable, toxic, radioactive, an oxidizer, an etiologic

The US Department of Transportation uses the following classifications of hazardous materials:
Flammable liquids & solids
Combustible liquids
Organic peroxides
Radioactive & corrosive materials
Explosives
Gases
Oxidizers
Blasting Agents
Irritants
Poisons

agent or highly reactive and which, because of handling, storing, processing or packaging may have detrimental effects upon the operating and emergency personnel, the public, equipment and/or the environment. The Secretary of Transportation is charged with classifying materials that are capable of posing an unreasonable risk to health, safety and property when transported for commerce. Hazardous materials are not necessarily wastes and can include pesticides, cleaning agents, water treatment chemicals and many household products.

A chemical accident is reported in the United States on average twenty-one times a day, one of which results in immediate injury, evacuation or death. The most common of these chemicals are: Anhydrous ammonia; chlorine; sulfuric acid; sulfur dioxide; and hydrochloric acid. Many accidents are caused by one of two reasons: human error or failed industrial storage and/or processes.

Previous Occurrences

Historically, oil and/or fuels represent the majority of spills requiring response from local hazmat teams. Other substances spilled include: anti-freeze, freon, propylene, mercury and natural gas.

Geographic Location

There are a number of major transportation routes in Tippecanoe County including an interstate, several state and US roads, and a fairly extensive railway system. Many of these transportation features both serve and cross populated areas; therefore, a hazardous material spill could easily affect populated areas. The contamination of our surface water, such as the Wabash River, could lead to contamination of areas outside our county boundaries, in addition to a local disaster.

Tippecanoe County has 11 routes that carry hazardous materials (SRs 25, 26, 28, 43, 52, 225, 443, US 52 and 231 as well as I-65). According to a 2012 Commodity Flow Study completed by INDOT, Tippecanoe County has a lower than expected HazMat density considering all the industry in the community, with only 4.08% of all commercial traffic carrying HazMat placards (average rates in Indiana are around 4.6%). As one might expect, I-65 carries the most hazardous material through our community. The study recommends that general HazMat response training would serve Tippecanoe County very well.

Hazard Extent

There are 269 hazardous waste facilities in Tippecanoe County; 135 of which are active. The active operators are comprised of the following: 19 Large Quantity Generators (LQG) which are also hazardous waste transporters; 19 Small Quantity Generators (SQG) and transporters; and 97 Conditionally Exempt Small Quantity Generators (CESQG), four of which are also transporters. A total of 52 facilities have been mapped and we will continue to update that information as locations are confirmed.

Hazardous material storage, transport and spills potentially affect a wide range of locations because the nature of the event is highly variable. A spill during transport could affect almost any area, including populated centers, depending on the event's location and method of transport. Other variables such as water contamination and airborne chemicals would extend the effects beyond the event area, creating a hazard of greater magnitude. Because there are so many unknowns associated with this particular hazard, it is difficult to judge its impact. The Planning Committee felt that an event could be catastrophic if the right combination of variables occurred simultaneously.

Probability of a Future Event

The probability of a hazardous material spill affecting Tippecanoe County, Shadeland and the cities of Lafayette and West Lafayette is highly likely. An event is likely in the towns of Dayton and Battle Ground because of their proximity to Interstate 65 and because rail lines run through both towns. While Clarks Hill is near SR 28 and US 52, it is relatively far from Interstate 65 and rail lines; therefore, the probability is less likely. Although there is little warning associated with a hazardous material spill, clean up can be difficult and lengthy. **Table 3-3** identifies the CPRI for hazardous material spill for each community.

Exhibit 9 Risk Index

Table 3-3: Calculated Priority Risk Index (CPRI) for Hazardous Materials

	Probability • Unlikely • Possible • Likely • Highly likely	**Magnitude/ Severity** • Negligible • Limited • Critical • Catastrophic	**Warning Time** • > 24 hrs • 12-24 hrs • 6-12 hrs • < 6 hrs	**Duration of Event** • < 6 hrs • < 1 day • < 1 wk • > 1 wk	**CPRI**
Tippecanoe Co.	Highly Likely	Catastrophic	< 6 hrs	< 1 wk	3.9
Lafayette	Highly Likely	Catastrophic	< 6 hrs	< 1 wk	3.9
West Lafayette	Highly Likely	Catastrophic	< 6 hrs	< 1 wk	3.9

Battle Ground	Likely	Catastrophic	< 6 hrs	< 1 wk	3.45
Dayton	Likely	Catastrophic	< 6 hrs	< 1 wk	3.45
Clarks Hill	Possible	Catastrophic	< 6 hrs	< 1 wk	3.0

According to the CPRI, all of the participating communities have a relatively high level of risk associated with hazardous material spills, with the Town of Clarks Hill having the least threat.

Vulnerability Analysis

Most of the population living in Tippecanoe County is at risk from contamination stemming from a hazardous materials spill. The unknown factors surrounding a hazard such as this make it difficult to quantify potential loss of life and environmental contamination. A serious spill could affect waterways, land, and the air we breathe as well as result in a monumental cleanup effort; while smaller spills can be handled in a more routine manner. Because of this hazard's inherent complexities, it is difficult to pre-determine how critical facilities would be affected.

Analysis of Development Trends

The most recent information in Tippecanoe County suggests that the population is growing modestly; Tippecanoe County's population increased 16% from 2000-2010.

The county continues to experience population flux from the older urban core to newer subdivisions along the interstate and other major arterials. This population flux has caused a decrease in enrollment in the Lafayette School Corporation and an increase in the Tippecanoe School Corporation, requiring additional educational facilities in the unincorporated county. Because a large section of the population lives in the county, many not only travel daily on major roads, but live near them as well. Additionally, the major rail corridor is located in downtown Lafayette, adjacent to the Wabash River.

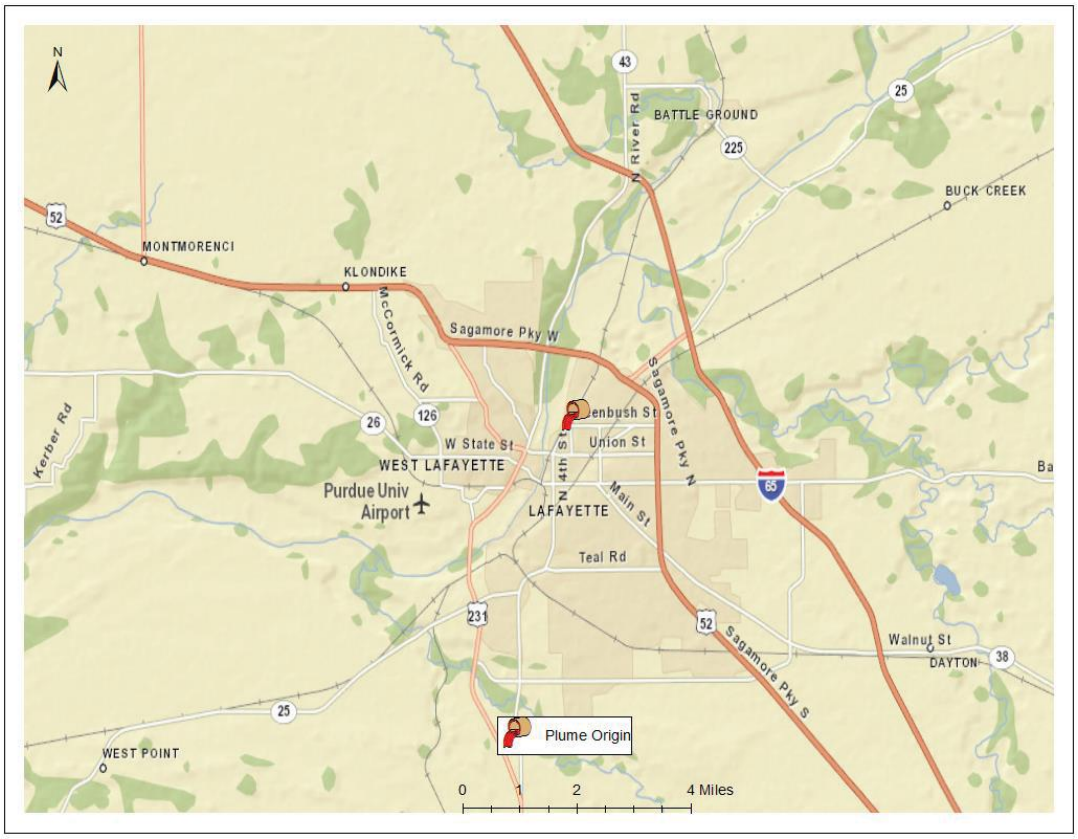
Several new schools, hospitals and Wabash Volunteer Fire Station have been constructed in the last five years; the new West Lafayette Fire Station at Kalberer & Salisbury was recently completed. Both the Wea Volunteer Fire Department and the Sheffield Volunteer Fire Department have constructed additions to their current facilities indicative of a growing population's needs. It is unclear whether there will be a need for additional critical and non-critical facilities in the near future.

However, one can assume that the need for critical facilities will rise with an increase in population. Critical facilities are almost always constructed in areas with good infrastructure near existing businesses; therefore, as additional critical facilities are constructed, they too, would also be at risk for damage from a hazardous waste spill.

GIS Hazardous Materials Release Analysis-Performed by the Polis Center

The U.S. EPA's ALOHA (Areal Locations of Hazardous Atmospheres) model was utilized to assess the area of impact for an ammonia release on railroad running across Lafayette community, adjacent Canal Road and Greenbush Street.

Exhibit 10 Plume Origin, (Polis Center)



ALOHA is a computer program designed especially for use by people responding to chemical accidents, as well as for emergency planning and training. Anhydrous ammonia is a common chemical used in industrial operations and can be found in either liquid or gas form. Rail and truck tankers commonly haul ammonia to and from facilities. For this scenario, moderate atmospheric and climatic conditions with a slight

breeze from the west were assumed. The target area was chosen due to its proximity to densely populated areas.

The source of the chemical spill is a cylindrical-shaped tank. The diameter of the tank was set to 8 feet and the length set to 33 feet (12,408 gallons). At the time of its release, it was estimated that the tank was 100% full. The ammonia in this tank is in its liquid state. This release was based on a leak from a 2.5 foot diameter hole, 12 inches above the bottom of the tank.

Exhibit 11 Plume Analysis (Polis Center)

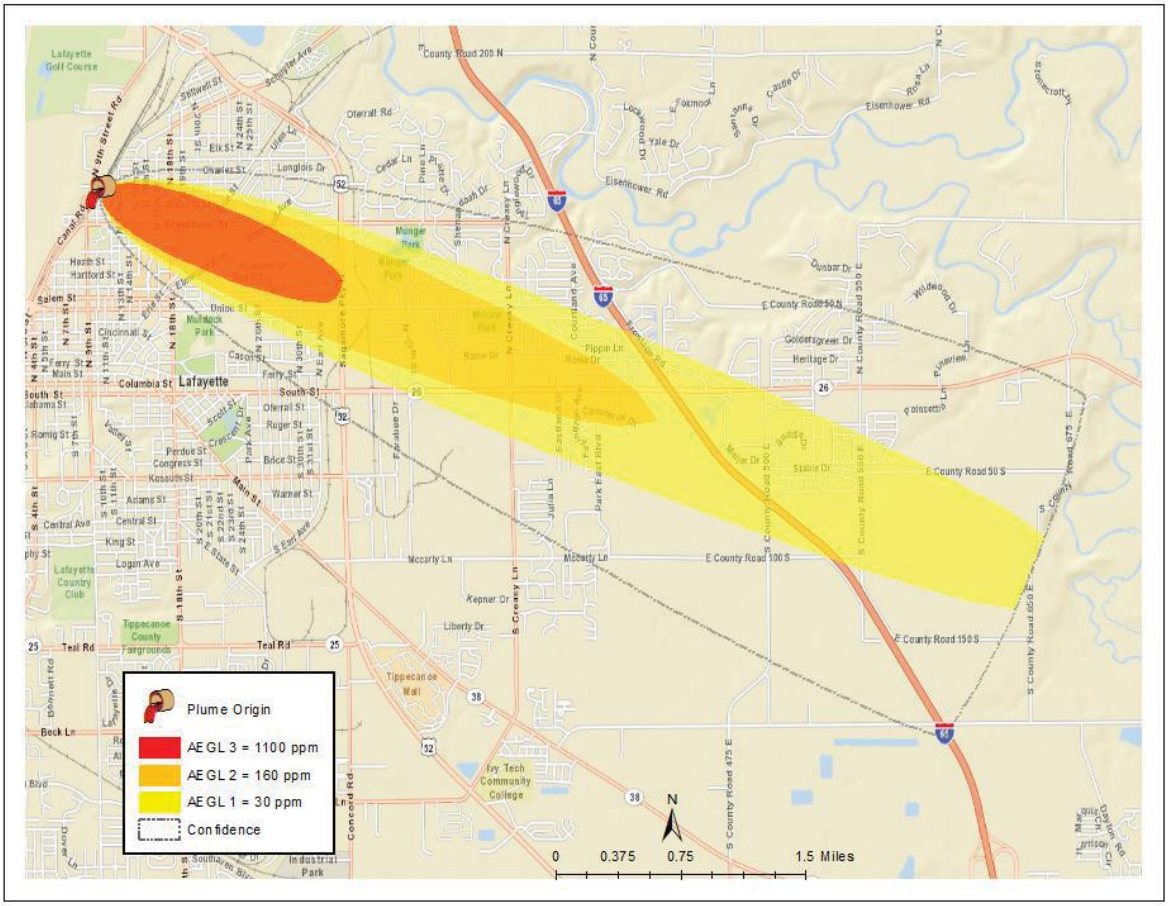

Plume Origin
AEGL 3 = 1100 ppm
AEGL 2 = 160 ppm
AEGL 1 = 30 ppm
Confidence
0
0.375
0.75
1.5 Miles
N
Lafayette
Columbia St
Teal Rd
Tippecanoe Mall
Ivy Tech Community College
Tippecanoe County Fairgrounds
Lafayette Country Club
Lafayette Golf Course
Munger Park
Mulbock Park
Industrial Park
Concord Rd
Creasy Ln
Eisenhower Rd
E County Road 100 S
E County Road 150 S
E County Road 50 S
E County Road 50 N
County Road 200 N
Mccarty Ln
Kepner Dr
Liberty Dr
Oferrall Rd
Cincinnati St
Ferry St
South St
Salem St
Hartford St
Heath St
Elk St
Longlois Dr
Cedar Ln
Pippin Ln
Rome Dr
Dunbar Dr
Heritage Dr
Stable Dr
Meyer Dr
Julia Ln
Park East Blvd
Courtland Ave
Fairview Dr
Sagamore Pkwy
Teal Rd
Beck Ln
Central Ave
Logan Ave
King St
Main St
Brice St
Warner St
Ruger St
Perdue St
Congress St
Kossuth St
Adams St
Scott St
Cincinnati St
Union St
Cason St
Columbia St
Canal Rd
Schuyler Ave
Stillwell St
Elk St
Charles St
Longlois Dr
Cedar Ln
Pierce Ln
Shenandoah Dr
Lockwood Dr
Yale Dr
Foxmoor
Cedar Dr
Rose Ln
Eisenhower Rd
Wildwood Dr
Goldenrod Dr
Pleasant Ln
Pleasant View
Lonecroft Ln
Dunbar Dr
Meadow

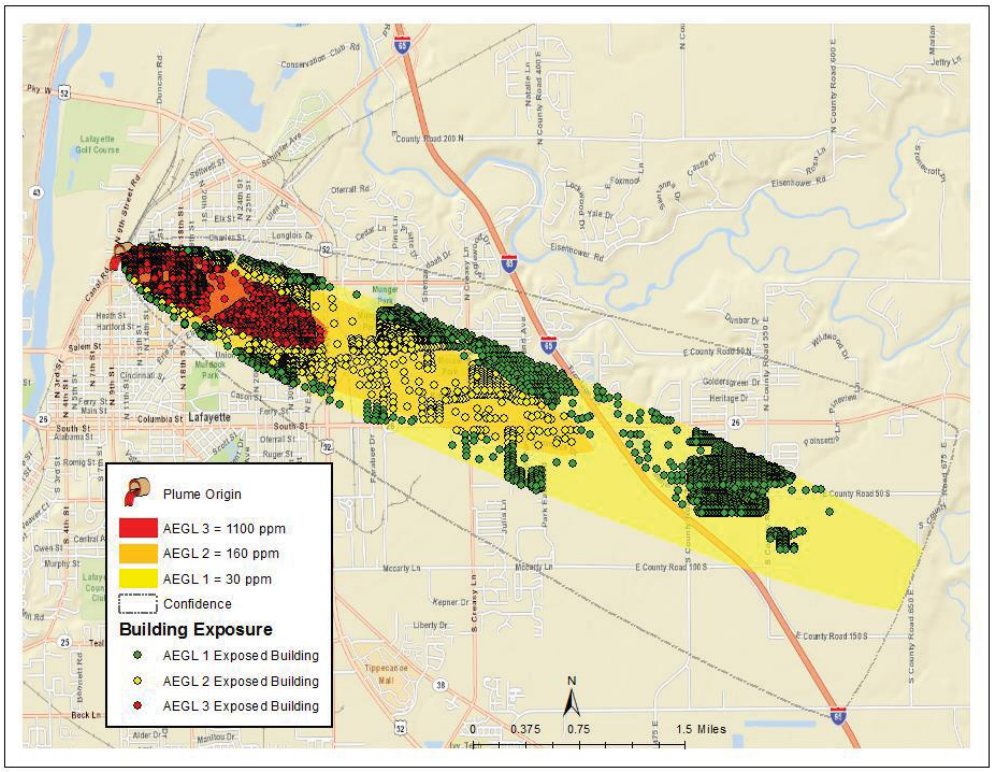
Exhibit 12 Building Ypes (Polis Center)

Occupancy	Population	Building Counts	Building Exposure
Residential	7,993	2,879	396,316,932
Commercial	0	284	312,527,090
Industrial	0	4	7,198,392
Agriculture	0	0	0
Religious	0	27	28,411,210
Government	0	3	2,085,150
Education	0	0	0
Total	**7,993**	**3,197**	**746,538,774**

Building Inventory Exposure

The results of the analysis against the Building Inventory points are depicted in the following tables. Exhibit 11 summarizes the results of the chemical spill by combining all AEGL zones. Exhibit 13 show the area affect by different zones.

Exhibit 13 Plume Buildings (Polis Center)



3.2.2 FLOODING

Nationwide, flooding is the most common and widespread of all natural disasters—except fire. A home in the floodplain has a 26% chance of flooding during the span of a thirty year mortgage and a 4% chance of catching on fire. Most communities in the United States have experienced some kind of flooding after spring rains, heavy thunderstorms or winter snow thaws.

A flood, as defined by the NFIP, is a "general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from overflow of inland or tidal waters and unusual and rapid accumulation of runoff of surface waters from any source, or a mudflow." Floods can be slow or fast rising but generally develop over a period of days. Mitigation includes any activity that prevents an emergency, reduces the chance of an emergency happening, or lessens the damaging effects of unavoidable emergencies. Investing in mitigation steps now, such as continuing floodplain management activities, prohibiting construction in the floodplain and encouraging the purchase of flood insurance will help reduce the amount of structural damage to homes and financial loss from building and crop damage should a flood or flash flood occur.

The standard for flooding is a 1% chance of flood water reaching a defined elevation each year; known as the 100-year flood. FEMA uses this benchmark to establish a standard of flood protection in communities throughout the country. Other terms that can be interchanged for the "100-year flood" are the "regulatory" and/or "base" flood. The term 100-year flood is often incorrectly used and can be misleading. It does not mean that only one flood of that size will occur in a 100 year period. It means that there is a 1% chance of a flood of that intensity and elevation happening every year, possibly occurring more than once in a relatively short period.

<u>Flooding: Recent Occurrences</u>

Flooding is a significant concern for Tippecanoe County. In just the last five years, Tippecanoe County has experienced 12 flooding events as reported to the NCDC (National Climactic Data Center).

Types of flooding recorded in Tippecanoe County include:

- Significant snow events combined with mixed precipitation (freezing rain, sleet) and rapidly warming temperatures (January 2009);
- Heavy rain resulting in both overland and riverine flooding, creating flash-flood like conditions (February 2009);
- Month-long showers followed by a day of intense rain (2-4 inches) contributing to rivers and creeks rising above flood stage (April 2009);
- Showers and thunderstorms with heavy precipitation resulting in flash flooding (July 2011);
- Above-average winter precipitation followed by a major thaw. The combination of the frozen ground, rapid snowmelt and additional rain caused lowland flooding, river flooding and ice jams extending 8-12 miles along portions of the Wabash River (January 2014).

Table 3-4 lists the 26 flood events recorded by the National Climatic Data Center (NCDC) that resulted in property damage since 2006. The NCDC listed 37 total flood events between 2006 and March 2014 for Tippecanoe County; 26 events caused property damage.

Exhibit 14 Flood Events

Table 3-4: Flood Events 2006-2014

Date	Waterway	Deaths	Injuries	Property Damage	Crop Damage
12/01/2006	Wabash	0	0	$10,000	0
12/22/2006	Wabash	0	0	$10,000	0
01/01/2007	Wabash	0	0	$10,000	0
02/27/2007	Wabash	0	0	$10,000	0
03/01/2007	Wabash	0	0	$10,000	0
04/01/2007	Wabash	0	0	$1,000	0
04/26/2007	Wabash	0	0	$5,000	0
11/22/2007	Wabash	0	0	$1,000	0
12/12/2007	Wabash	0	0	$500	0
12/23/2007	Wabash	00	0	$500	0
12/29/2007	Wabash	0	0	$500	0
01/01/2008	Wabash	0	0	$1,000	0
01/09/2008	Tippecanoe River	0	0	$500,000	0
02/05/2008	Wabash	0	0	$400,000	0
02/05/2008	Wildcat Creek	0	0	$7,000	0
03/03/2008	Wabash	0	0	$15,000	0
03/19/2008	Wabash	0	0	$12,000	0

Table 3-4: Flood Events 2006-2014					
Date	**Waterway**	**Deaths**	**Injuries**	**Property Damage**	**Crop Damage**
03/28/2008	Wabash	0	0	$12,000	0
04/11/2008	Wabash	0	0	$5,000	0
05/15/2008	Wabash	0	0	$5,000	$5,000
05/31/2008	Wabash	0	0	$5,000	$5,000
06/01/2008	Wabash	0	0	$2,000	$2,000
05/14/2009	Wabash	0	0	0	$5,000
07/02/2011	Wabash	0	0	$500	$500
11/14/2011	Overland	0	0	$1,000	0
02/22/2014	Wabash/Wildcat	0	0	$450,000	0
Total Damage				$1,474,000	$17,500

Geographic Location

Tippecanoe County has two rivers, several creeks and several tributaries. The primary sources of flooding in the county are the Wabash River, the Tippecanoe River, Wildcat Creek, Wea Creek, Burnetts Creek and Indian Creek. The county has also experienced flooding associated with Hadley Lake, Celery Bog and overland flooding triggered by poor drainage. The Tippecanoe River enters the county from Carroll County along the northern border and is approximately 5.5 miles in length before its confluence with the Wabash. The Wabash River enters the county at the northeast corner and flows between the downtown areas of the cities of Lafayette and West Lafayette. It exits on the county's western edge near the halfway point of that border. Wildcat Creek flows through the eastern part of the county and empties into the Wabash near the center of the county. **Table 3-5** contains a list of the seven USGS stream gauges located in Tippecanoe County. In the previous version of this plan, there were twelve stream gauges. There are several reasons for this drop in stream gauges: according to the USGS Water Sciences Center, many gauges are in place for short study periods; when the data is collected the gauges are no longer needed. Full record stream gauges can also be discontinued because there is no longer funding for the gauge. About 60% of the USGS Indiana network is funded through reimbursable dollars with other agencies such as the State of Indiana, Army Corps of Engineers, and local governments. Sometimes those agencies can no longer fund a gauge, so the station is discontinued. Locations of the stream gauges are indicated below in Table 3-5.

Exhibit 15 Stream Gauges

Table 3-5: USGS Stream Gauges in Tippecanoe County	
USGS Site Number	**Site Name**
03334500	South Fork-Wildcat Creek near Lafayette
03335000	Wildcat Creek near Lafayette
03335500	Wabash River at Lafayette
03335671	Elliott Ditch near Lafayette
033356725	Elliott Ditch near Elston
03335673	Little Wea Creek at South Raub
033356786	Little Pine Creek near Montmorenci
03329900	Wabash River at Americus
03333080	Tippecanoe River at Americus

Hazard Extent

Riverine flooding is the most common type of flooding in Tippecanoe County. Parts of the county have also experienced overland flooding, flash flooding, lake flooding (associated with Hadley Lake) and urban flooding. While the primary flooding sources are rivers and creeks, flooding can also occur in urban areas because of increased impervious surfaces and inadequate drainage. Flooding and associated crop damage is most likely to occur during the spring and summer because of heavy rains, sometimes exacerbated by melting snow. However, flooding can happen at any time given the right set of circumstances. Tippecanoe County has experienced two recent flood events; the most destructive occurred in the midst of the second snowiest winter since 1981. Warming temperatures during the week of February 18-22 melted most of the snow cover in Tippecanoe County. The combination of the frozen ground, rapid snowmelt and nearly an inch of additional rain caused widespread flooding. On February 22, an eight-mile long ice jam located in Carroll County broke up and headed down the Wabash River at a 6 mph pace. When the ice jam stopped, water containing slabs of ice, trees and limbs, began to cover the area along Barton Beach Road causing $450,000 in damage to homes, vehicles and roads.

The West Lafayette wastewater treatment plant could be inundated by flood waters in the future as could the Wea Fire Department. Most critical facilities are not directly threatened by flood waters. There are issues with the RiverBend Hospital (formerly Wabash Valley) when North River Road becomes inundated and access is restricted. In response, INDOT and the Area Plan Commission have programmed $625,000 ($500,000 federal share) to raise approximately 1,200 feet of North River Road by 3 feet. This will be a County project beginning in 2018. In addition to critical facilities, which are

covered more thoroughly in the section entitled ***Tippecanoe County Flood Damage***, based on information from the IDNR, the county also has a handful of Repetitive Loss Structures.

FEMA defines a repetitive loss structure as a structure covered by a contract of flood insurance issued under the National Flood Insurance Program (NFIP), which has suffered flood loss damage on two occasions during a 10-year period that ends on the date of the second loss, in which the cost to repair the flood damage is 25% of the market value of the structure at the time of each flood loss.

The Indiana State NFIP Coordinator and FEMA Region V were contacted to determine the number of repetitive loss structures. FEMA Region V reported 1 structure in City of West Lafayette that is considered to be a Repetitive Loss Structure. Two other structures in unincorporated areas of Tippecanoe County are also considered as Repetitive Loss Structures. Exhibit 16 documents the Tippecanoe County repetitive loss data as of July 2, 2015.

Exhibit 16 Repetitive Loss Data

Community	**Repetitive loss $**	**Repetitive loss #**
	Value	**Value**
Tippecanoe County	$ 988,463.83	22
Battle Ground	$ 117,246.15	2
Lafayette	$ -	0
West Lafayette	$ 3,493.36	1
Shadeland	$ -	0
Clarks Hill	$ -	0
Dayton	$ -	0

In 2008 the Indiana Legislature amended the Indiana Code. The change permits reconstruction of a house in the floodway that was substantially damaged by any means (not just flooding) provided it can be elevated more than 2′ above the regulatory flood (flood protection grade) and meet other construction criteria.

Probability of a Future Event

The probability of a flood affecting most communities in Tippecanoe County is highly likely, with the exception of the Town of Dayton. While rivers and streams traverse through most of the county, Dayton does not have any special flood hazard area

according to the Flood Insurance Rate Maps. Like Dayton, the Town of Clarks Hill does not have any floodplains; however, the town does suffer from overland flooding made worse by poor drainage. The Planning Committee figured the Calculated Priority Risk Index for each community in Tippecanoe County by considering past events and at-risk facilities in each jurisdiction. **Table 3-6** identifies the CPRI for flooding for each community.

Exhibit 17 Flooding Risk Index

Table 3-6: Calculated Priority Risk Index (CPRI) for Flooding

	Probability • Unlikely • Possible • Likely • Highly likely	**Magnitude/ Severity** • Negligible • Limited • Critical • Catastrophic	**Warning Time** • > 24 hrs • 12-24 hrs • 6-12 hrs • < 6 hrs	**Duration of Event** • < 6 hrs • < 1 day • < 1 wk • > 1 wk	**CPRI**
Tippecanoe Co.	Highly Likely	Critical	< 6 hrs	>1 wk	3.7
Lafayette	Highly Likely	Critical	> 24 hrs	>1 wk	3.25
West Lafayette	Highly Likely	Catastrophic	> 24 hrs	>1 wk	3.55
Battle Ground	Highly Likely	Limited	< 6 hrs	< 1 wk	3.3
Dayton	Possible	Negligible	12-24 hrs	< 1 wk	1.8
Clarks Hill	Highly Likely	Critical	< 6 hrs	< 1 wk	3.6

According to the CPRI, many communities in Tippecanoe County are highly likely to experience flooding. Those communities include: the unincorporated county, the two cities, and the Towns of Battle Ground, Clarks Hill and Shadeland. The Town of Dayton is the only community likely to experience a negligible affect due to flooding.

Vulnerability Analysis

Many communities in Tippecanoe County are at risk of flood damage and unlike other hazards, floods are generally easier to predict. In many flood events, rivers and streams raise gradually giving notice to owners of property in the floodplain; however, some areas of the county have experienced flash floods, which are characterized by fast rising water and diminished warning time. Past flood events give valuable information regarding the type of damage that can be expected from floods with different crests as well as knowledge about which areas will be inundated.

Because Tippecanoe County has long suffered from flood related damage, the county and member jurisdictions have adopted ordinances regarding the floodplain that are stricter than the current state and federal regulations. A summary of local Flood Plain ordinances, past damage and potential damage is covered in the next two sections.

Local Flood Plain Ordinances

Since 1965, the year the first Unified Zoning Ordinance (UZO) was adopted in Tippecanoe County, floodplains have been a distinct zoning district. The FP zone prohibits dwellings and other enclosed and roofed buildings. Any dwelling that pre-dates the 1965 UZO is legally non-conforming and is subject to the rules governing non-conforming uses and buildings in the Flood Plain Zone. This method of floodplain stewardship has ensured that no new dwellings have been legally constructed in the 100-year floodplain and non-conforming homes eventually come down when they are substantially damaged. Our regulations significantly mitigate risk to persons and property, reducing over time the number of homes and other buildings located in our floodplains.

Base Flood Elevation
The elevation of the flood that has a 1 percent chance of occurring in a given year; also known as the 1 percent annual chance flood, or a 100 year flood.

The Unified Zoning Ordinance adopted by most of the jurisdictions (excepting Shadeland) represented in this planning process currently requires a 25′ no-building setback from the FP zone boundary and requires the first floor elevation (including basements and crawl spaces) of all structures built within the next 75′ to be built at flood protection grade (2′ above the regulatory flood elevation).

However, in response to the 2008 change in the Indiana Code and by request of the county commissioners to provide relief to persons whose homes were damaged by recent floods, the Unified Zoning Ordinance was updated to reflect the statewide change. Amendment #63, approved in late 2009 allowed the elevation of qualifying (substantially damaged or repetitive loss) existing single-family homes located within the Flood Plain zone. This amendment had a sunset date of January 2013. Amendment #65 reset the clock to July 2013 and #77 further extended the deadline to December 2013, #79 pushed it back to July 1, 2014.

In the meantime, at the request of a County Commissioner, staff looked at expanding the elevation language to permit elevation of residences in the flood plain that have not had a determination of substantial damage. Ordinance Amendment #83 permits the

elevation of existing residences in the flood plain until December 2015, regardless of whether the structures have suffered repetitive loss or substantial damage.

Although Shadeland is not a participating member of the Area Plan Commission of Tippecanoe County, it has similar regulations and became a member of the NFIP in 2012 (a goal of this plan). Additionally, jurisdictions participating in this process have adopted a zoning district known as the Flood Plain (FP) zone.

> The Town of Shadeland has its own set of regulations in its *Municipal Code – Town of Shadeland*. It prohibits the construction of buildings within 100' of the floodplain zone boundary and such buildings must comply with the flood protection grade. Additionally, construction of walled structures in the floodplain is prohibited.

The Indiana Department of Natural Resources, in partnership with the Federal Emergency Management Agency (FEMA) began a state-wide Floodplain Mapping Initiative in 2004 to revise outdated maps for all 92 Indiana counties. The new digital floodplain maps were based on updated topographic and orthographic data, and in some cases, revised hydrologic and hydraulic analysis. A series of public meetings were held for Tippecanoe County home owners affected by map changes in February of 2008; the maps were officially adopted in fall 2009. This was done in order to meet the National Flood Insurance Program requirements.

Because residences and walled structures are not permitted in the FP zone, existing homes below the base flood elevation (BFE) are considered non-complying and/or non-conforming uses and structures, respectively, in the flood plain. These structures are subject to the restrictions and requirements of UZO 5-1-11. That section of the ordinance states that when a non-complying use or non-conforming structure (i.e. home and accessory buildings) in the FP zone is substantially damaged by any means to the extent that repairs would equal or exceed 50% of the market value of the home and/or outbuildings, it will no longer be allowed. The ordinance also limits the amount of permitted repairs. Repairs to a non-conforming home or structure cannot exceed 10% of the market value in any 1 year period and cumulatively may not equal or exceed 50% of the market value of that structure. The "50% rule" is cumulative in nature so that if 20% in repairs are made over time and then the structure is damaged by 30%, it could not be repaired and must be removed, because cumulatively it would have been damaged by 50% of its market value.

<u>Tippecanoe County Flood Damage</u>

Because Tippecanoe County has long restricted construction in the floodplain, most of the homes are older and some were originally cottages that were subsequently converted into homes without approval.

Under the 2009-2014 UZO Amendments, seven homes have been elevated. The ability to elevate a single-family residence in the flood plain will sunset on December 1, 2015. The average price of a home in the flood plain is $76,000.

Exhibit 18 Flood Policies

Table 3-7: Tippecanoe County Flood Policies		
Jurisdiction	**Number of Policies**	**Insurance In-Force Whole $**
Battle Ground	6	$ 913,000
Lafayette	71	$ 14,626,800
Unincorporated	197	$ 35,486,600
West Lafayette	23	$ 6,998,700

In the fall of 2009, Tippecanoe County, the Cities of West Lafayette and Lafayette, Dayton and Battle Ground adopted new FIRM maps. In the 2006 plan, only 231 structures were located in the floodplain. Because of updated floodplain mapping, there are now 726 primary use structures and 538 other structures within the limits of the floodplain for a total of 1,264. This increase in structures in the floodplain can be explained by the increase in the extent of the floodplains as identified by FEMA. However, FEMA neglected to exclude those properties that had already successfully submitted a LOMA (Letter of Map Amendment) removing it from the floodplain. As more and more homeowners either remove their homes from the new floodplains or submit an elevation certificate stating that their home is above the BFE, we expect to see the number of structures in the floodplain drop dramatically.

Exhibit 19 Building in Floodplain

Table 3-8 gives a breakdown of residences and other structures located in the floodplain based on GIS mapping with a digitized FIRM overlay as of February 2014.

Table 3-8: Total Buildings in the Floodplain		
Community	**Primary Use Buildings**	**Other Structures**
Tippecanoe County	526	448
Lafayette	144	53
West Lafayette	27	4
Battle Ground	12	11
Dayton	0	0

Shadeland	8	18
Clarks Hill	0	0
Total	717	534

Note: Table includes critical and non-critical facilities

One issue associated with flooding that may not be well reflected in **Table 3-7** is the problem of access. State Road 43, the primary access to the Indiana Veteran's Home and River Bend Hospital, is often obstructed by flood waters. To address the problem of access, INDOT is funding most of the project for Tippecanoe County to elevate North River Road by 3.5′ so its elevation is above that of the Base Flood of 526.5′. Construction on the $625,000 project will begin in 2018 and has been added as a mitigation project in this plan. Access can be further complicated by utility failure. **Table 3-8** shows critical facilities located in the floodplain by NFIP community.

Exhibit 20 Critical Facilities in Flood Plain

Table 3-9: Critical Facilities Located in the Floodplain	
Community Name	**Critical Facility**
West Lafayette	Wastewater Treatment Facility (portion)
Lafayette	Hazardous Materials Facilities, Potable Water Wells (13)
Tippecanoe County	Fire Station
Dayton	NA
Battle Ground	Wastewater Treatment Facility (portion)

An essential facility will encounter many of the same impacts as other buildings within the flood boundary. These impacts can include structural failure, extensive water damage to the facility and loss of facility functionality (e.g. a damaged fire station will no longer be able to serve the community). The results of the overlay analysis indicate that thirteen essential facilities in Tippecanoe County could sustain damage. One Fire Station, in the unincorporated community is within the 1% flood probability area.

Exhibit 21 Building Damaged by Community and Occupancy (Polis Center)

Community	Total Buildings Damaged	Building Occupancy Class						
		Agriculture	Commercial	Education	Government	Industrial	Religious	Residential
Battle Ground	6							6
Clarks Hill								
Dayton								
Lafayette	114		16		2		3	93

Shadeland	13	6						7
West Lafayette	5							5
Unincorporated	773	126	9		3	3	4	628
Total	911	132	25		5	3	7	739

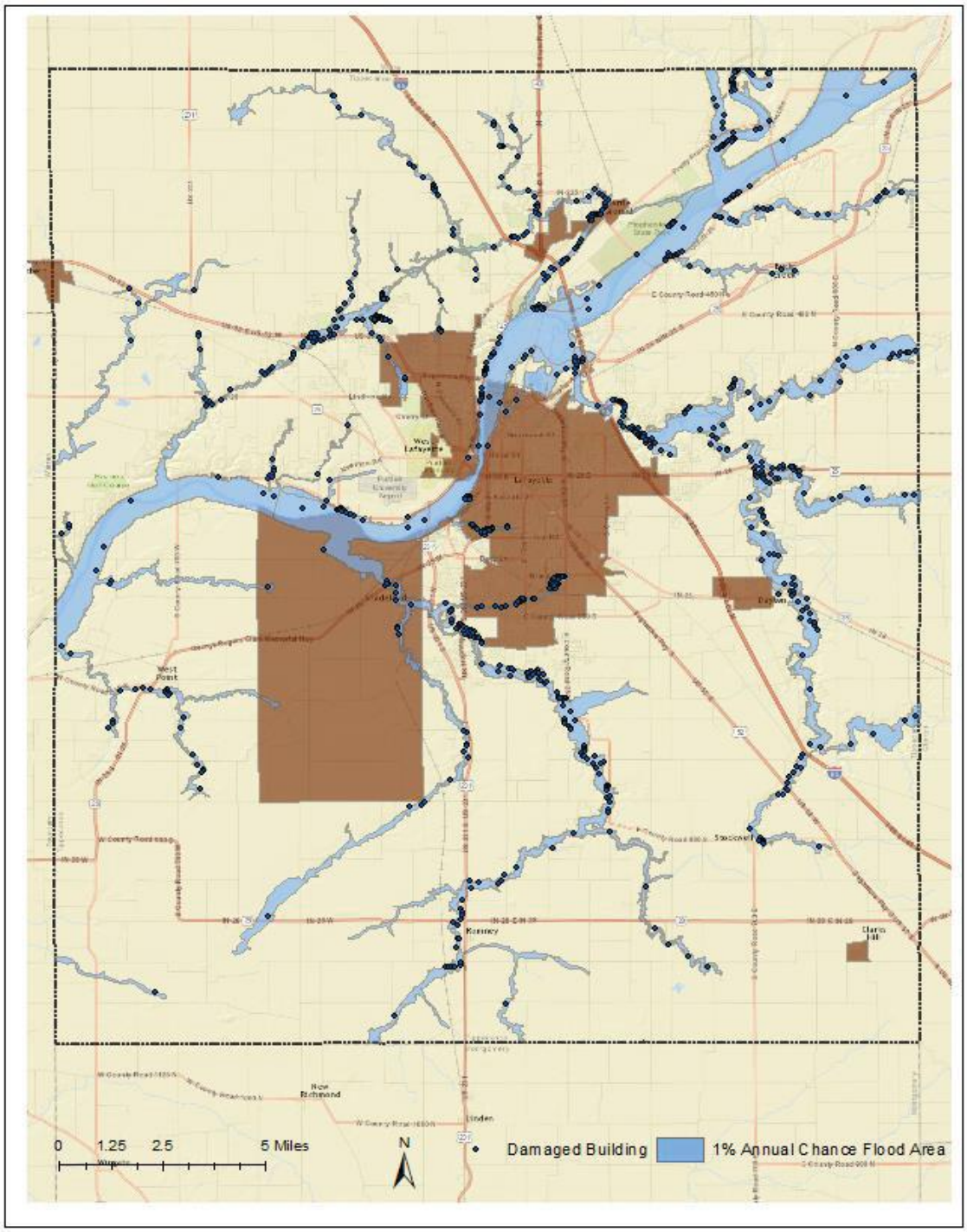
Exhibit 22 Cost of Buildings Damaged by Community and Occupancy (Polis Center)

Community	Total Losses ($)	Building Occupancy Class						
		Agriculture	Commercial	Education	Government	Industrial	Religious	Residential
Battle Ground	355,265							355,265
Clarks Hill								
Dayton								
Lafayette	11,580,877		3,748,302		317,125		1,475,561	6,039,889
Shadeland	1,221,651	725,443						496,208
West Lafayette	12,811,800							12,811,800
Unincorporated	78,661,362	10,210,321	2,376,900		12,556	453,084	4,981,034	60,627,467
Total	104,630,955	10,935,764	6,125,202		329,681	453,084	6,456,59,	80,330,629

Vulnerability Analysis Conducted by Polis Center

Hazus-MH estimates the 1%-annual-chance flood (AKA 100-year flood) would damage 911 buildings at a replacement cost of $104,631,000. Lafayette community sustained the most damage with 114 buildings damaged at a replacement cost of $11,581,000. West Lafayette sustained considerably higher damage compared to Lafayette with 5 buildings at a replacement cost of $12,812,000. Exhibit 23 depicts the Tippecanoe County parcel points that fall within the 1%-annual-chance flood risk area (AKA 100-year floodplain).

Exhibit 23 Structures Damaged in Flood (Polis Center)



Structures Damaged in Simulation Conducted by Polis Center

Analysis of Development Trends

All of the communities involved in this planning effort prohibit construction in the floodplain; therefore, it is unlikely that new structures would be constructed in areas susceptible to flooding. Risks associated with increased impervious surfaces could lead to more urban area flooding. Continued diligence in floodplain management will be necessary.

3.2.3 TORNADO/WINDSTORM

The Indiana State Climate Office defines tornadoes 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; the violently rotating column of air may reach the ground very quickly and thus, become a tornado. An event that lifts and blows debris around is considered a tornado. Tornado damage results from high wind velocity and wind-blown debris. In Indiana, tornado season is generally March through June; however, tornadoes can occur at any time. They tend to occur in the afternoon and evening; over 80% of all tornadoes strike between 3pm and 9pm. While most tornadoes (69%) have winds of less than 100 miles per hour, 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 railroad train 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. Windstorms or high winds can result from thunderstorms' inflow and outflow. They can result from strong frontal systems, or gradient winds (high or low pressure systems). High winds have a speed reaching 50-mph or greater, either sustained or gusting. Straight line or downburst winds result from collapsed storm clouds. Straight line winds are responsible for most wind damage associated with thunderstorms and can reach speeds of 100 – 150 mph.

According to the National Oceanic and Atmospheric Administration, 2011 holds the record as the deadliest year for tornadoes since 1953 with 549 people killed. The massive F-4 Joplin, Missouri tornado in early summer 2011 is the deadliest single tornado since record keeping began in 1950, killing 157 people.

A tornado is generated when conditions in a strong thunderstorm cell produce a mass of cool air that overrides a layer of warm air. The underlying warm air is then forced to rise rapidly while the cool air drops, sparking the swirling action.

Previous Occurrences

Although outside what is referred to as Tornado Alley (the central plains) where tornadoes are more frequent, Tippecanoe County is not immune to tornadoes and windstorms. The standard for measuring magnitude of tornadoes for 40 years was the Fujita scale introduced in 1971. In February 2007, the National Weather Service introduced the *Enhanced Fujita Scale*. This new scale has the same basic design as the original Fujita scale: six categories from zero to five representing increasing degrees of damage (EF0-EF5). It was revised to reflect better examinations of tornado damage surveys, so as to align wind speeds more closely with associated storm damage. More information on the EF scale and damage estimates can be found at http://www.spc.noaa.gov/faq/tornado/ef-scale.html.

The National Climactic Data Center (NCDC) has only recently started providing EF data. The Fujita Scale of Tornado Intensity is used to categorize tornado events and is shown in **Table 3-11**. The scale scores an F0 tornado as weakest tornado event with an F5 being the strongest (NOAA, 2011).

Exhibit 24 Tornado Intensity

Table 3-10: Fujita Scale of Tornado Intensity

F-Scale	Winds	Character of Damage	Relative Frequency
F0 (weak)	40-72 mph	Light damage	30%
F1 (weak)	73-112 mph	Moderate damage	35%
F2 (strong)	113-157 mph	Considerable damage	25%
F3 (strong)	158-206 mph	Severe damage	2%
F4 (violent)	207-260 mph	Devastating damage	7%
F5 (violent)	261-318 mph	Incredible damage	<1%

The NCDC has information on all 39 recorded tornadoes in Tippecanoe County. **Table 3-12** contains tornado data for tornadoes that have occurred since the 2006 plan (2006 through tornado season 2013). Based on that information, the county has experienced 12-F0, 14-F1, 10-F2, 1-F3 and 3-F4 events in the last fifty-eight years. The most significant event, an F4, occurred in March of 1976 and resulted in $2.5 billion in damages and six injuries. Tippecanoe County has experienced a fair amount of damage resulting from one outbreak of tornadoes on a Sunday afternoon in November 2013. In Indiana alone, 29 tornadoes were reported; Tippecanoe County recorded an EF3 that damaged Mintonye Elementary School, the Subaru plant and Voest Alpine on the

southeast side of Lafayette. Tornado data from before 2006 can be found in **Appendix C.**

Exhibit 25 Tornado Damage

Table 3-11: Tornado Damage 2006-2014				
Location	**Date**	**Magnitude**	**Death/Injury**	**Property Damage/ Crop Damage**
Romney	04/02/2006	F1	0/0	$50,000/0
Cairo	04/14/2006	F0	0/0	0/0
Americus	04/14/2006	F1	0/0	$30,000/0
Odell	06/25/2006	F0	0/0	$3,000/$2,000
Taylors	04/19/2011	F1	0/0	$80,000/0
Buck Creek	04/19/2011	F0	0/0	$15,000/0
South Raub	11/17/2013	EF2	0/0	$125,000/0
South Raub	11/17/2013	EF0	0/0	$21,000/0
Concord	11/17/2013	EF1	0/0	$10,000/0
Odell	11/17/2013	EF2	0/0	$10,000/0
North Crane	11/17/2013	EF3	0/0	$750,000/0
Total 2006-2014			**0/0**	**$1,094,000/ $2,000**
Total 1953-2014			**3/87**	**$11.1 Million / $2,000**

NCDC lists 110 thunderstorm/wind events since 1959. However, **Table 3-13** includes only those storms that resulted in damage or injury and occurred **since 2006**. Total property damage from thunderstorm/wind events in 2006-2014 totaled $322,450. The most damaging windstorm occurred in June of 2002 and resulted in $220,000 in damage. **Appendix E** includes historical wind/thunderstorm damage data.

Exhibit 26 Thunderstorm Damage

Table 3-12: Wind/Thunderstorm Damage 2006-2014				
Location	**Date**	**Magnitude (knots)**	**Death/Injury**	**Property Damage/ Crop Damage**
West Lafayette	05/18/2006	50 knots	0/0	$30,000/0
Stockwell	05/25/2006	60 knots	0/0	$5,000/0
Colburn	08/23/2006	50 knots	0/0	$3,000/0
Lafayette	10/03/2006	50 knots	0/1	$10,000/0
Romney	08/19/2007	50 knots	0/0	$1,000/0
Lafayette	10/18/2007	56 knots	0/0	$2,000/0
Lafayette	06/15/2008	50 knots	0/0	$60,000/0
Monroe	12/27/2008	70 knots	0/0	$1,000/0

Stockwell	12/27/2008	65 knots	0/0	$7,000/0
Dayton	03/08/2009	52 knots	0/1	$12,000/0
Battle Ground	06/01/2009	52 knots	0/0	$2,500/0
West Lafayette	08/19/2009	52 knots	0/0	$1,000/0
Lafayette	08/19/2009	52 knots	0/0	$1,000/0
Lafayette	05/03/2010	61 knots	0/0	$10,000/0
East Yard	06/02/2010	61 knots	0/0	$15,000/0
Romney	06/13/2010	56 knots	0/0	$1,000/0
Shadeland	06/14/2010	61 knots	0/0	$12,500/0
Lafayette	06/18/2010	52 knots	0/0	$1,000/0
Battle Ground	06/18/2010	70 knots	0/0	$6,000/0
Taylor	06/21/2010	55 knots	0/0	$1,000/0
Lafayette	07/17/2010	52 knots	0/0	$3,000/0
Purdue University	07/17/2010	63 knots	0/0	$45,000/0
Romney	08/04/2010	56 knots	0/0	$1,000/0
Elston	04/04/2011	56 knots	0/0	$15,000/0
Purdue University	05/25/2011	61 knots	0/0	$7,000/0
Battle Ground	06/04/2011	56 knots	0/0	$6,000/0
West Lafayette	06/04/2011	50 knots	0/0	$5,000/0
Clarks Hill	06/21/2011	43 knots	0/0	$1,000/0
Purdue University	06/21/2011	56 knots	0/0	$7,000/0
West Lafayette	06/21/2011	43 knots	1/1	$10,000/0
Americus	07/02/2011	56 knots	0/0	$7,000/0
Laf. Aretz Airport	07/02/2011	56 knots	0/0	$5,000/0
Lafayette	08/08/2011	52 knots	0/0	$1,000/0
Battle Ground	08/13/2011	56 knots	0/0	$10,000/0
West Lafayette	08/13/2011	52 knots	0/0	$4,000/0
Lafayette	08/24/2011	56 knots	0/0	$1,000/0
Klondike	05/06/2012	48 knots	0/0	$700/0
Lafayette	05/06/2012	48 knots	0/0	$750/0
Dayton	08/09/2012	56 knots	0/0	$9,000/0
Romney	08/09/2012	56 knots	0/0	$6,000/0
Colburn	08/16/2012	52 knots	0/0	$1,000/0
Monitor	08/16/2012	52 knots	0/0	$1,000/0
Lafayette	08/16/2012	52 knots	0/0	$2,000/0
Buck Creek	06/12/2013	52 knots	0/0	$2,000/0
Battle Ground	06/24/2013	56 knots	0/0	$5,000/0
Battle Ground	06/24/2013	52 knots	0/0	$2,000/0
Klondike	06/24/2013	52 knots	0/0	$1,000/0
Total 2006-2011			**1/3**	**$322,450 / 0**
Total 1989-2011			**1/5**	**$1,265,450/$5,000**

Geographic Location

Past tornadoes in this county have generally originated in the southwest and moved in a northeasterly direction. Tornadoes have been recorded in all parts of this county including the Cities of Lafayette and West Lafayette, the Towns of Battle Ground and Dayton and the unincorporated town of Romney. The image below illustrates the historical tornado activity in Tippecanoe County.

There are seventy-one outdoor warning sirens in Tippecanoe County; the majority of those are located in the Cities of Lafayette and West Lafayette as well as around their fringe areas. Smaller towns such as Dayton, Battle Ground, Romney, West Point, Clarks Hill, Montmorenci, and Colburn also have sirens. There are an additional fifteen sirens covering the rural part of the county. Three sirens have been added since the adoption of the 2006 plan; these sirens are located on Purdue's campus and provide mainly redundant coverage.

Hazard Extent

Past tornadoes have been devastating for many communities within Tippecanoe County. According to the NCDC, three tornadoes have caused a minimum of one million dollars' worth of property damage or more. A 1976-F4 tornado caused $2.5 million worth of property damage and resulted in 6 injuries. In 1994 a tornado, also an F4, struck west of West Lafayette and caused five million dollars' worth of property damage; it also resulted in three deaths and seventy injuries. In May of 2004 an F2 tornado struck Dayton causing one million dollars' worth of property damage; the town was again struck by a tornado in July of 2005. Five tornadoes of varying degrees have caused $200,000 or more damage in the county, West Lafayette and Battle Ground.

Outdoor warning sirens are essential for notifying the public of an approaching tornado or dangerous storm with high winds. The locations of the county's sirens are shown in Exhibit 4. When the 2004 tornado struck Dayton, the siren did not work and residents did not receive proper warning. The town raised the money to replace the siren, which proved beneficial when a second tornado struck in the summer of 2005.

The Ordinance Committee of the Area Plan Commission discussed the idea of requiring developers to install tornado warning sirens in new developments in the early 2000s. The amendment never progressed but this USO change has been included as a mitigation project.

The existing 71 tornado sirens provide good coverage for the urban areas and some areas of the county. However, portions of Battle Ground and Clarks Hill are not covered by existing sirens; furthermore the town of Americus does not have any outdoor warning sirens.

Additionally there are two schools in Shadeland and a portion of the Purdue University campus (including the airport which is the only public airport in the county) that are not covered by warning sirens.

Probability of Future Event

The probability of a future tornado or windstorm event is highly likely in Tippecanoe County. The warning time is limited at best and can sometimes be just a few minutes; likewise, the duration is also relatively short. Past events have proven that the severity and magnitude of these hazards can be devastating, despite the short time frame. **Table 3-14** identifies the Calculated Priority Risk Index (CPRI) for a tornado and/or windstorm event.

Exhibit 27 Risk Index for Tornado

Table 3-13: Calculated Priority Risk Index (CPRI) for Tornado/Windstorm

	Probability • Unlikely • Possible • Likely • Highly likely	**Magnitude/ Severity** • Negligible • Limited • Critical • Catastrophic	**Warning Time** • >24 hrs • 12-24 hrs • 6-12 hrs • < 6 hrs	**Duration of Event** • <6 hrs • <1 day • < 1 wk • > 1 wk	**CPRI**
Tippecanoe Co.	Highly Likely	Catastrophic	< 6 hrs	< 6 hrs	3.7
Lafayette	Highly Likely	Catastrophic	< 6 hrs	< 6 hrs	3.7
West Lafayette	Highly Likely	Catastrophic	< 6 hrs	< 6 hrs	3.7
Battle Ground	Highly Likely	Catastrophic	< 6 hrs	< 6 hrs	3.7
Dayton	Highly Likely	Catastrophic	< 6 hrs	< 6 hrs	3.7
Clarks Hill	Highly Likely	Catastrophic	< 6 hrs	< 6 hrs	3.7

According to the CPRI, the probability of a tornado or windstorm event is equal for all of the communities within Tippecanoe County.

Vulnerability Analysis

All communities within Tippecanoe County are at risk of a tornado or windstorm event. It is difficult to predict where and when a tornado or strong wind will materialize and estimating potential losses is difficult based on the unpredictable nature of these events. Past events give some indication of the type of damage that can be expected with

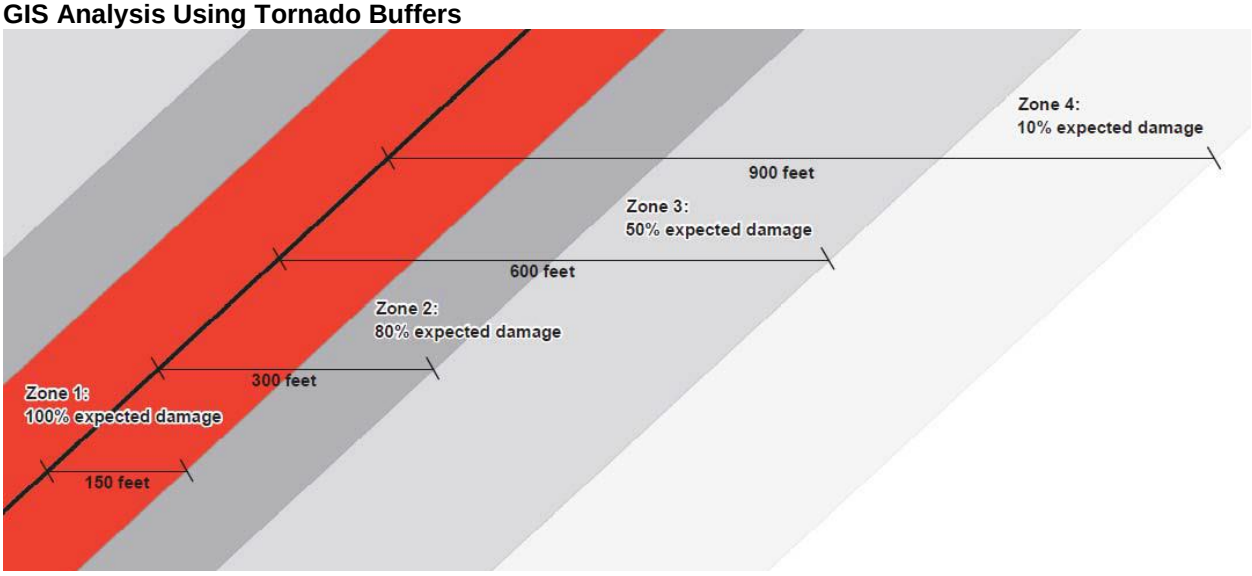
tornadoes of varying intensity. The tornadoes in November 2013 caused the largest amount of damage in recent history at nearly one million dollars.

Exhibit 28 Fujita Scale

Tornado Zones and Damage Curves

Fujita Scale	Zone	Buffer (feet)	Damage Curve (%)
F-4	4	600-900	10
F-4	3	300-600	50
F-4	2	150-300	80
F-4	1	0-150	100

GIS Analysis Using Tornado Buffers



Historically, F1 tornadoes have caused serious property damage in Tippecanoe County; at least four F1 events have individually caused more than $200,000 dollars in damage. The most damaging tornadoes have naturally been F4 events; one caused $2.5 million worth of damage in 1976 and $5 million worth of damage resulted from a 1994 event. A direct tornado strike on a populated area could be catastrophic. Because of the nature and complexity of tornados and windstorms, it is impossible at this time to identify the specific number and value of critical facilities that would be adversely affected by this hazard.

GIS Tornado Analysis

GIS overlay modeling was used to determine the potential impacts of an F4 tornado. The analysis used a hypothetical tornado path that runs for 8.4 miles through Tippecanoe County communities.

Exhibit 29 Tornado Path (Polis Center)

Hypothetical F4 Tornado Path in Tippecanoe County

The GIS analysis estimates that 2,898 buildings will be damaged. The estimated building losses were $233 million. The building losses are an estimate of building replacement costs multiplied by the percentages of damage. The overlay was performed against parcels that were joined with Assessor records showing property replacement value.

Exhibit 30 Tornado Damage (Polis Center)

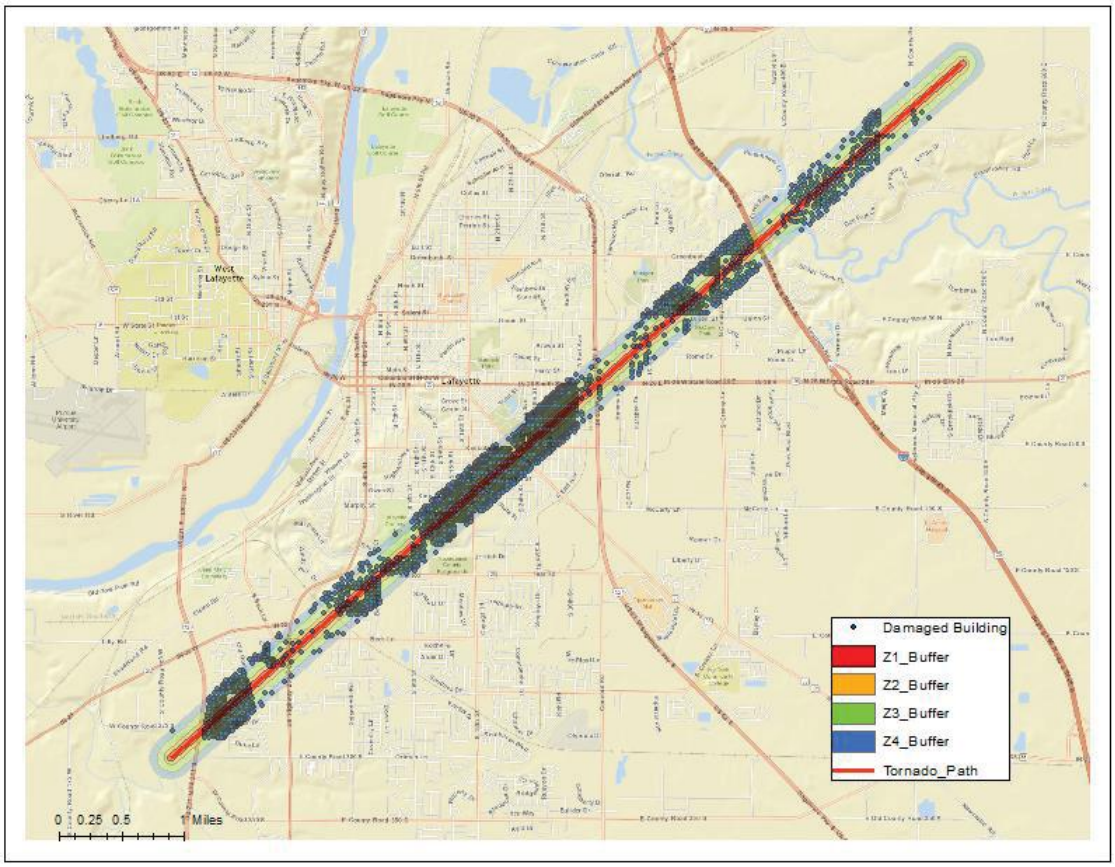
Estimated Numbers of Buildings Damaged and Loss by Occupancy Type

Occupancy	Building Losses ($)	Damaged Buildings

Commercial	36,970,932	120
Industrial	305,305	1
Religious	6,531,609	12
Residential	189,176,341	2,765
Total	232,984,187	2,898

Exhibit 31 Tornado Damage (Polis Center)

Modeled F4 Tornado Damage Buffers in Tippecanoe County



Analysis of Development Trends

The most recent information in Tippecanoe County suggests that the population is growing modestly; Tippecanoe County's population increased 16% from 2000-2010. It is unclear whether there will be need for additional critical and non-critical facilities in the near future though one can assume that the need for critical facilities will rise with an increase in population. As it is impossible to determine most likely areas affected by

tornadic activity, when additional critical facilities are constructed, they too will be exposed to potential damage from tornado related losses.

3.2.4 SEVERE WINTER STORM

Winter storms come in different forms, ranging from moderate to heavy snow to blizzards or an ice storm. Each storm can be accompanied by other weather events such as high winds, freezing rain or sleet blinding wind-driven snow and extremely cold temperatures that can last for several days. The main components of a winter storm are blowing and drifting snow accompanied by cold temperatures. Depending on a storm's size, it could affect several states or a smaller area within a single state or region. A severe winter storm is one that drops 4 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 contact with other surfaces.

All winter storms make traveling, either by car, bicycle or foot, extremely hazardous. The aftermath of a winter storm can affect a community or region for days, weeks, and even months especially if utility outages are caused by the storm.

Severe winter storms can lead to various problems, including stranded motorists and trapped residents who are further burdened by power outages and lack of supplies. Residents, travelers and livestock may become stranded without adequate food, water and fuel supplies. Some winter storms can also cause flooding depending on temperatures and duration of snow melt. Winter storms are considered deceptive killers because they indirectly cause traffic accidents, injury and death resulting from exhaustion/overexertion, hypothermia and frostbite from cold temperature and wind exposure; house fires occur more frequently in the winter because proper safety precautions are not taken. The use of unsafe heating techniques can lead to carbon monoxide poisoning and fire related deaths.

> The polar vortex is a semi-permanent low-pressure weather system located in the Northern Hemisphere. In 2013-2014, part of this weather system broke apart from its normal center in Canada and Arctic air remained positioned over the Great Lakes until late March 2014.

Wind chill is an index that expresses how cold it feels to exposed skin outside when the effects of temperature and wind speed are combined. On November 1, 2001, the National Weather Service (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 an area. A winter storm warning indicates that severe winter weather conditions are expected. 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. Blizzards are characterized by low temperatures (usually 20 degrees or less), sustained wind, and falling or blowing snow that reduces visibility to ¼ mile or less for a duration of three hours or more.

NOAA defines the following types of winter precipitation:
Flurries: Light snow falling for short durations. No accumulation.
Showers: Snow falling at varying intensities for brief periods of time. Some accumulation possible.
Squalls: Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant.
Blowing Snow: Wind driven snow that reduces visibility and causes significant drifting.
Blizzard: Winds over 35mph with snow and blowing reducing visibility to near zero.
Sleet: Rain drops that freeze into ice pellets before reaching the ground. Sleet usually does not stick but can accumulate like snow and cause driving hazards.
Freezing Rain: Rain that falls onto a surface with a temperature below freezing. This causes it to freeze to surfaces such as trees, cars and roads. Even small accumulations can cause a significant hazard.

Previous Occurrences

There have been several severe winter storms recorded in Tippecanoe County. A severe storm in January 1978 stopped almost all activity in Indiana for two weeks and a severe ice storm in the early 90s resulted in a disaster declaration. A January 2005 ice storm resulted in $300,000 worth of damage and led to another disaster declaration (the declaration also included a flood event). A record level of snow during the period of February 12-14 2007 prompted an Emergency Disaster Declaration for Tippecanoe County, including 47 other counties in Indiana. Thanks to the Canadian Polar Vortex, the winter of 2013-2014 was the 9th coldest winter on record in Indiana, with the coldest temperatures in the Greater Lafayette area registering -15ºF. Additionally, an average winter in Indiana sees about 26.3" of snowfall; 59.4" fell in the winter of 2013-2014 in two winter storms. Though cold weather and snow records were set, no property damage or deaths was reported as a result of any winter storm events.

According to data from the National Climatic Data Center, there have been 28 snow and ice storms reported in Tippecanoe County from 1950-August 2011. The events from 2006-2014 are listed in the **Historical Severe Winter Storm Data** table below.

Exhibit 32 Winter Storms

Historical Severe Winter Storm Data					
Location	**Date**	**Type**	**Precipitation**	**Death/ Injury**	**Property Damage/Crop Damage**
Tippecanoe Co. +	02/12/2007	Winter Storm	Freezing rain, ~12" snow	0/0	0/0
Tippecanoe Co. +	02/24/2007	Ice Storm	Ice	0/0	0/0
Tippecanoe Co. +	12/09/2007	Ice Storm	.25" ice	0/0	$300,000 /0
Tippecanoe Co. +	02/01/2008	Winter Storm	7" snow	0/0	0/0
Tippecanoe Co. +	01/07/2010	Winter Storm	3-6" snow	0/0	0/0
Tippecanoe Co. +	02/01/2011	Winter Storm	4" sleet; 2" snow	0/0	0/0
Tippecanoe Co. +	03/05/2013	Winter Storm	6" snow	0/0	0/0
Tippecanoe Co. +	03/24/2013	Winter Storm	9-10" snow	0/0	0/0
Tippecanoe Co. +	01/05/2014	Winter Storm	8-12" snow	0/0	0/0
Tippecanoe Co. +	02/04/2014	Winter Storm	7-9" snow	0/0	0/0
Total 2006-2014				**0/0**	**$300,000/0**
Total 1950-2014				**0/0**	**$600,000/0**

(NCDC, 2014) Note: "County+" denotes that more than Tippecanoe County was affected; NA indicates information was not available. Previous storms are listed in the 2005 MHMP.

Geographic Location

Severe winter storms generally affect regions, several counties or States; therefore, all localities in Tippecanoe County are subject to a severe winter storm. Because Interstate 65 cuts through the county, there is an increased number of traveling motorists at risk of being stranded in the community. While Tippecanoe County receives less snow than other areas of the state, especially those near Lake Michigan, it is still at risk for severe snow and ice storms.

Hazard Extent

Severe winter storms consisting of freezing rain, sleet, heavy snow, blizzards, icy conditions, extreme low temperatures, and strong winds are common during winter months in Tippecanoe County. Such conditions can result in personal and property damage, interruption of economic activity in the community, and possibly death.

Probability of Future Event

The probability of a severe winter storm causing disruption to residents and businesses in Tippecanoe County is highly likely. The warning time associated with severe winter storms is generous, typically12-24 hours, but the duration of the event could be more than a week. The **Calculated Priority Risk Index for Severe Winter Storm** table identifies the Calculated Priority Risk Index (CPRI) for a severe winter storm in this county.

> From January 31-February 2, 2010, Tippecanoe County received 6-8" of snowfall on top on an inch of sleet that made roadways very slick and hazardous. As the storm progressed and winds increased, a travel advisory was issued and power outages were widespread.

Vulnerability Analysis

The entire population of Tippecanoe County is at risk during a severe winter storm event. Persons who are critically ill and rely on medication and/or electricity to run medical equipment have a heightened risk when power fails or transportation is restricted. The complexity and nature of a regional hazard event such as this makes it difficult to quantify potential losses to property and infrastructure. Typically, severe winter storms will affect roadways and may cause utility failures that could create a threat to human safety. Potential future problems can be extrapolated from the effects of past events that have disrupted community function in the county. Although the 1978 blizzard shut down the county for more than a week, heavy snow storms typically cause no more than a few days of disruption.

Exhibit 33 Risk Index Winter Storms

Calculated Priority Risk Index (CPRI) for Severe Winter Storm					
	Probability • Unlikely • Possible • Likely • Highly likely	**Magnitude/ Severity** • Negligible • Limited • Critical • Catastrophic	**Warning Time** • > 24 hrs • 12-24 hrs • 6-12 hrs • < 6 hrs	**Duration of Event** • < 6 hrs • < 1 day • < 1 wk • > 1 wk	**CPRI**
Tippecanoe Co.	Highly Likely	Critical	12-24 hrs	< 1 wk	3.3
Lafayette	Highly Likely	Critical	12-24 hrs	< 1 wk	3.3
Battle Ground	Highly Likely	Critical	12-24 hrs	< 1 wk	3.3
Dayton	Highly Likely	Critical	12-24 hrs	< 1 wk	3.3
Clarks Hill	Highly Likely	Critical	12-24 hrs	< 1 wk	3.3

According to the CPRI, all communities in Tippecanoe County could be equally affected by a severe winter storm.

It is difficult to predict which communities would be affected by loss associated with disruption to all economic activity, infrastructure maintenance, and utility repair and how long the disruption will last. Due to the nature and complexity of severe winter storm events, it is not possible at this time to identify the number and value of specific critical and non-critical facilities that would be adversely affected by severe winter storms. However, it is well-known that backup generators are essential for some facilities such as hospitals and nursing homes.

Analysis of Development Trends

As additional critical facilities are constructed, they too, will be exposed to potential damage from severe winter storm related losses.

3.2.5 EARTHQUAKE

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

> An 8.9 magnitude earthquake, the world's fifth largest, struck Japan on March 11, 2011. The National Police Agency in Japan estimated over 15,000 fatalities and 45,700 destroyed buildings. The American Red Cross has pegged total damage at over $1 billion.

plates break free, causing the ground to shake. Although most earthquakes occur at boundaries where the plates meet, some occur in the middle of plates.

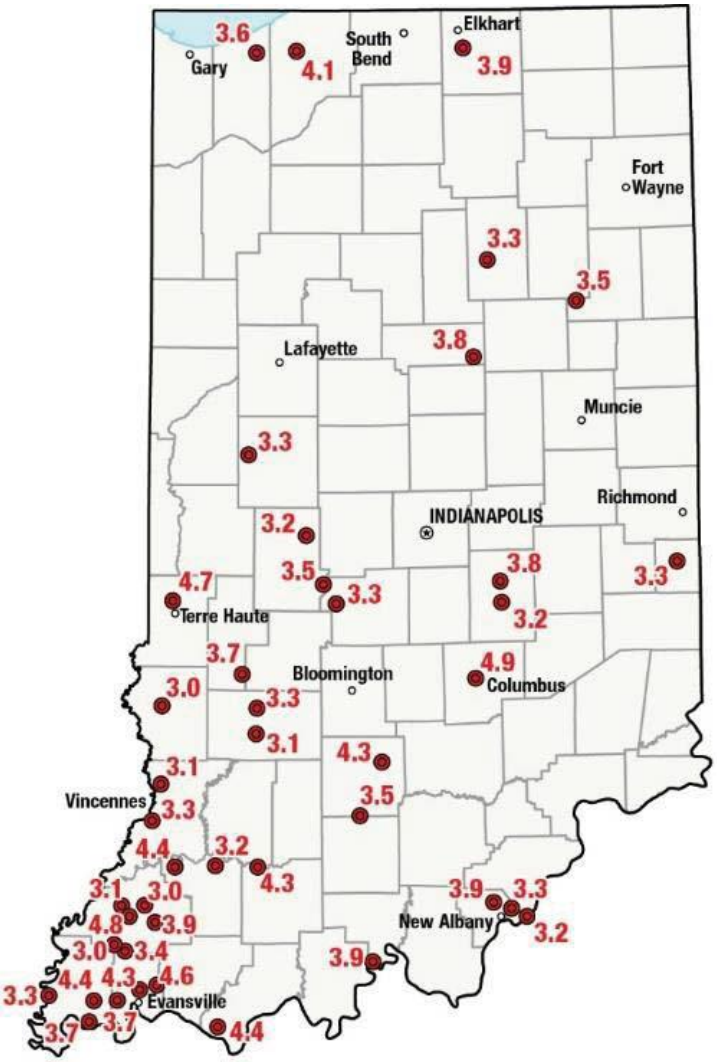
There are 45 states and territories in the United States at moderate to very high risk from earthquakes, and they are located in every region of the country. California experiences the most frequent damaging earthquakes; however, Alaska experiences the greatest number of large earthquakes—mostly in uninhabited 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 included three quakes thought to have a magnitude of 8 or more on the Richter scale. Those particular quakes occurred over the Eastern United States, with Missouri, Tennessee, Kentucky, Indiana, Illinois, Ohio, Alabama, Arkansas, and Mississippi experiencing the strongest ground shaking.

Previous Occurrences

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 known as tsunamis. Buildings and foundations resting on unconsolidated landfill and other unstable soil, and mobile homes and/or 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 death, injuries, and extensive property damage. Earthquakes strike suddenly, without warning, and can occur at any time. On a yearly basis, 70 to 75 damaging earthquakes occur throughout the world.

Based on local data, the most recent earthquake felt in Tippecanoe County was in April 2008, though there was no damage reported from this event. The epicenter of the 5.2 magnitude quake was near Mt. Carmel, Illinois (about 38 miles northwest of Evansville, IN). The most recent quake recorded in central Indiana was on December 30, 2010 centered in Greentown, Indiana, and measured 3.8 on the Richter scale of earthquake intensity. The most serious quakes affecting this part of Indiana were the 1811-1812 Great New Madrid Earthquakes. The three largest of these earthquakes from that series are believed to have had a magnitude greater than 8.0 on the Richter scale, with hundreds of aftershocks at varying magnitude ranges. The most significant damage was in the New Madrid Seismic Zone in Southern Illinois.

Exhibit 34 Historical Earthquake Locations (Indiana Geological Survey)



Geographic Location

Tippecanoe County is located on the northern end of the New Madrid Seismic Zone as well as near the Wabash Valley Seismic Zone along the Wabash River.

Southwestern Indiana is most vulnerable to experiencing an intense earthquake. A massive influx of refugees from the Evansville and Vincennes will be an impact from an earthquake in area of the state. According to the Indiana Geological Survey, there is a

25-40% chance that a quake with a magnitude of 6.0 and higher will hit the Evansville area in the next 50 years. While Tippecanoe County may not lie directly on a fault line, our community will inevitably experience effects of a "big one."

Probability of Future Event

Based on historical earthquake data, local knowledge of previous earthquake events, and the HAZUS-MH results conducted as part of this planning process, it is probable that future earthquakes will occur in Tippecanoe County. The county is located on the northern tip of the New Madrid Seismic Zone and in the Wabash Valley Seismic Zone and because parts of the county are densely populated, the magnitude or severity of an earthquake event could be significant. If an earthquake were to occur, the warning time and duration of the event would both be relatively short. The table below identifies the Calculated Priority Risk Index (CPRI) for an earthquake event in Tippecanoe County.

Exhibit 35 Risk Index Earthquakes

Calculated Priority Risk Index (CPRI) for Earthquake					
	Probability • Unlikely • Possible • Likely • Highly likely	**Magnitude/ Severity** • Negligible • Limited • Critical • Catastrophic	**Warning Time** • > 24 hrs • 12-24 hrs • 6-12 hrs • < 6 hrs	**Duration of Event** • < 6 hrs • < 1 day • < 1 wk • > 1 wk	**CPRI**
Tippecanoe Co.	Highly Likely	Limited	< 6hrs	< 6hrs	3.1
Lafayette	Highly Likely	Limited	< 6hrs	< 6hrs	3.1
West Lafayette	Highly Likely	Limited	< 6hrs	< 6hrs	3.1
Battle Ground	Highly Likely	Limited	< 6hrs	< 6hrs	3.1
Dayton	Highly Likely	Limited	< 6hrs	< 6hrs	3.1
Clarks Hill	Highly Likely	Limited	< 6hrs	< 6hrs	3.1

According to the CPRI, an earthquake event would be a highly likely event with a limited risk potential for all communities in Tippecanoe County.

Vulnerability Analysis

The entire population of Tippecanoe County is identified as being at risk. The HAZUS-MH Earthquake Model was used to estimate potential losses in Tippecanoe County.

The model results indicate that there would be no building damage and/or life losses. Earthquakes are unpredictable and it is therefore impossible to determine the number and value of critical facilities that could be affected by this hazard. New development vulnerability will be minimal due to new construction codes coupled with low earthquake probability.

Hazus-MH Earthquake Analysis

The Polis Center reviewed existing geological information and recommendations for earthquake scenarios and ran four modeling scenarios—two deterministic, one probabilistic, and an annualized loss.

The deterministic scenarios included a 7.7-magnitude epicenter along the New Madrid fault zone and a 6.8-magnitude epicenter in Mount Carmel, Illinois.

Modeling a deterministic scenario requires user input for a variety of parameters. One of the most critical sources of information required for accurate assessment of earthquake risk is soils data. Fortunately, a National Earthquake Hazards Reduction Program (NEHRP) soil classification map exists for Indiana. NEHRP soil classifications portray the degree of shear-wave amplification that can occur during ground shaking. The Indiana State Geological Survey supplied the soils map used for the analysis. FEMA provided a map for liquefaction potential that was used by Hazus-MH.

An earthquake depth of 10.0 kilometers was selected based on input from the Indiana Geological Survey. Hazus-MH also requires the user to define an attenuation function unless ground motion maps are supplied. Because Indiana has experienced smaller earthquakes, the decision was made to use the Central Eastern United States (CEUS) attenuation function.

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with the inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The probabilistic scenario was based on ground-shaking parameters derived from US Geological Survey probabilistic seismic hazard curves. The probabilistic scenario was a 500-year return period scenario.

This analysis evaluates the average impacts of a multitude of possible earthquake epicenters with a magnitude that would be typical of that expected for a 500-year return period. These analysis options were chosen because they are useful for prioritization of seismic reduction measures and for simulating mitigation strategies.

Results for Hazus 7.7 Magnitude- New Madrid, Missouri Earthquake Scenario

Hazus estimates that the damages incurred from the 7.7 magnitude New Madrid earthquake scenario would be county-wide in scope.

- Building Damages

Hazus estimates that 36 buildings in Tippecanoe County would be at least moderately damaged. This is slightly larger than 0% of the buildings in the county. The model estimates that no buildings would be damaged beyond repair. Table 13 lists the numbers and occupancy types of buildings that would be damaged.

Exhibit 36 Building Damage New Madrid (Polis Data)

New Madrid Scenario- Building Damage of Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	314	0.63	2	1.72	1	2.43	0	3.20	0	1.96
Commercial	2,634	5.27	7	4.90	2	6.16	0	7.87	0	5.17
Education	113	0.23	0	0.20	0	0.26	0	0.33	0	0.35
Government	65	0.13	0	0.11	0	0.13	0	0.16	0	0.19
Industrial	677	1.35	2	1.63	1	2.09	0	2.64	0	1.50
Other Residential	10,035	20.09	23	16.37	6	17.82	0	10.76	0	9.07
Religion	279	0.56	1	0.63	0	0.83	0	1.08	0	0.85
Single Family	35,846	71.75	107	74.44	23	70.28	2	73.97	0	80.91
Total	**49,962**		**143**		**33**		**3**		**0**	

New Madrid Scenario- Direct Economic Losses due to building damage

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.00	0.03	0.00	0.01	0.04
	Capital-Related	0.00	0.00	0.03	0.00	0.00	0.04
	Rental	0.03	0.01	0.03	0.00	0.00	0.07
	Relocation	0.11	0.01	0.03	0.01	0.02	0.18
	Subtotal	**0.14**	**0.03**	**0.13**	**0.01**	**0.03**	**0.34**
Capital Stock Losses							
	Structural	0.21	0.02	0.04	0.01	0.03	0.32
	Non_Structural	0.32	0.04	0.04	0.01	0.02	0.44
	Content	0.02	0.00	0.01	0.00	0.00	0.04
	Inventory	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.56**	**0.07**	**0.08**	**0.03**	**0.05**	**0.79**
	Total	**0.70**	**0.10**	**0.21**	**0.04**	**0.08**	**1.13**

Results for Hazus 6.8 Magnitude- Mt. Carmel, Illinois Earthquake Scenario

The extent of the damages from a 6.8 Magnitude at Mt. Carmel, Illinois would encompass all areas of Tippecanoe County.

- Building Damages

Hazus estimates that 956 buildings in Tippecanoe County would be at least moderately damaged. This is over 2% of the buildings in the county. An estimated nine buildings would be damaged beyond repair.

Exhibit 37 Building Damage Mt. Carmel (Polis Data)

Mt. Carmel Scenario- Building Damage of Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	284	0.61	22	0.75	10	1.19	2	1.64	0	1.04
Commercial	2,396	5.17	168	5.88	67	7.94	11	10.43	1	7.79
Education	102	0.22	7	0.25	3	0.36	0	0.44	0	0.52
Government	60	0.13	4	0.13	1	0.18	0	0.20	0	0.24
Industrial	615	1.33	43	1.51	18	2.16	3	2.83	0	1.78
Other Residential	9,147	19.75	664	23.19	231	27.43	21	20.02	2	18.08
Religion	253	0.55	19	0.65	8	0.90	1	1.21	0	1.14
Single Family	33,464	72.24	1,937	67.64	505	59.85	66	63.23	7	69.41
Total	**46,321**		**2,863**		**843**		**104**		**9**	

Mt. Carmel Scenario- Direct Economic Losses due to building damage

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.23	2.60	0.12	0.25	3.19
	Capital-Related	0.00	0.10	2.13	0.07	0.07	2.37
	Rental	0.71	1.38	1.61	0.05	0.09	3.85
	Relocation	2.61	0.95	2.52	0.23	0.82	7.13
	Subtotal	**3.32**	**2.67**	**8.85**	**0.47**	**1.22**	**16.54**
Capital Stock Losses							
	Structural	4.59	2.48	2.57	0.50	0.73	10.87
	Non_Structural	9.07	5.64	3.65	0.68	1.15	20.19
	Content	1.21	0.74	1.31	0.39	0.40	4.04
	Inventory	0.00	0.00	0.05	0.09	0.01	0.15
	Subtotal	**14.87**	**8.85**	**7.57**	**1.67**	**2.28**	**35.24**
	Total	**18.19**	**11.52**	**16.42**	**2.14**	**3.50**	**51.78**

Results for Probabilistic 500-Year Earthquake Scenario

Hazus-MH estimates that approximately 734 buildings will be at least moderately damaged. This is over 1% of the total number of buildings in the region. The model estimates that no buildings will be damaged beyond repair.

The aggregate building related losses totaled $40.74 million; 31% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up more than 57% of the total loss.

Exhibit 38 Building Damage Probabilistic 500 Year Scenario

Probabilistic 500-Year Scenario-Damage Counts by Building Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	291	0.62	18	0.76	8	1.17	1	1.58	0	0.98
Commercial	2,443	5.19	139	6.02	52	8.05	8	10.52	1	7.68
Education	104	0.22	6	0.26	2	0.36	0	0.45	0	0.51
Government	61	0.13	3	0.13	1	0.18	0	0.20	0	0.23
Industrial	628	1.33	36	1.55	14	2.18	2	2.83	0	1.74
Other Residential	9,321	19.79	547	23.65	180	27.69	15	19.76	1	17.65
Religion	258	0.55	15	0.66	6	0.92	1	1.23	0	1.14
Single Family	33,988	72.17	1,550	66.97	387	59.45	48	63.43	5	70.08
Total	**47,092**		**2,315**		**651**		**76**		**7**	

Probabilistic 500-Year Scenario-Building Losses in Millions of Dollars

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.18	2.01	0.09	0.20	2.47
	Capital-Related	0.00	0.08	1.65	0.05	0.05	1.83
	Rental	0.54	1.07	1.25	0.04	0.07	2.97
	Relocation	1.98	0.73	1.93	0.18	0.63	5.44
	Subtotal	**2.52**	**2.06**	**6.83**	**0.36**	**0.94**	**12.72**
Capital Stock Losses							
	Structural	3.53	1.93	1.97	0.39	0.56	8.37
	Non_Structural	7.05	4.50	2.93	0.58	0.91	15.97
	Content	1.07	0.66	1.13	0.34	0.35	3.55
	Inventory	0.00	0.00	0.04	0.08	0.01	0.13
	Subtotal	**11.65**	**7.09**	**6.07**	**1.39**	**1.82**	**28.02**
	Total	**14.17**	**9.15**	**12.90**	**1.76**	**2.76**	**40.74**

Analysis of Development Trends

A reasonable expectation would be that the need for critical facilities would rise with an increase in population and in turn, new critical facilities would also be exposed to potential damage from an earthquake.

3.2.6 DAM FAILURE

There are approximately 80,000 dams in the United States today; the majority of which are privately owned. Other owners include state and local authorities, public utilities, and federal agencies. Dams can provide many benefits to a region, such as drinking water, navigation, water for irrigation, hydroelectric power, and recreation areas and can help reduce the devastation caused by flooding. However, dams can also pose a risk to communities. Dams can fail whether they are built correctly or not because of different variables such as a lifetime of poor maintenance, flood conditions or an earthquake.

Historically, dam failures have resulted in the loss of life and in many instances the failure happened relatively quickly.

On March 11, 2009, the flow of water over the Oakdale Dam in White County reached 25,000 cubic feet/second. According to NOAA, at that rate of flow, major to near record flooding will occur along the Tippecanoe River. Evacuation of many people downstream of the Oakdale Dam in flood prone areas is necessary. Flooding will close many local roads, some covered by over one foot of water. Substantial property damage will occur downstream of the dam. Flooded areas may include Horseshoe Bend and Camp Tecumseh.

Normal flow level over the Oakdale Dam is 2,000 cubic feet/second.

Dam failure can be arranged into four classifications:

- overtopping;
- foundation failure;
- structural failure; and
- other unforeseen failures.

Uncontrolled water flowing over, around and adjacent to a dam results in an overtopping failure, which accounts for about 28% of failures. Earthen dams are most susceptible to this type of breech. Foundation and structural failures are generally tied to seepage through the foundation of the main structure of the dam. Deformation of the foundation or settling of the embankment can also result in dam failure. Structural failures account for approximately 28% of failures and foundation problems account for another 25%. Earthquakes or sabotage account for 12% of dam failures, while inadequate design and construction account for the remaining 7% of failures.

Previous Occurrence

To date, there have been no dam breaks in Tippecanoe County. However, the Oakdale Dam in Carroll County has overflowed as a result of heavy rains. Water released from the two upstream dams, Oakdale and Norway, on the Tippecanoe River can greatly affect flooding in this county.

Geographic Location

There are five dams in Tippecanoe County: one high hazard, two significant hazard and two low hazard dams. Additionally, there is one high hazard dam upstream in Carroll County and a significant hazard dam in White County. A group of approximately 50 homes located on Goldsberry Road (permanent residences for the most part) and Morningside Lane (some of which serve as summer residences) are downstream from the Oakdale Dam; there are no critical facilities located in downstream paths.

Hazard Extent

Four assumptions were made to estimate potential losses for dam failure for this planning effort:

- dam failure would occur during dry weather;
- area of inundation was estimated based on judgment;
- only high and significant hazard dams were considered; and
- structures in the path of the dam failure could be substantially damaged.

Approximately seventy-seven buildings could be affected by dam failures based on address points downstream of the Dams. A failure of the Oakdale Dam in Carroll County could affect fifty-two residential and ten agricultural buildings along Goldsberry Road and Morningside Lane, causing an estimated $6.9 and $1.1 million worth of damage respectively. A failure of the Treece Lake Dam could affect fifteen residential buildings and result in $2 million dollars in property damage along Sugar Creek Road. Dry weather dam failures of the Norway (Lake Shafer) Dam in White County and two local dams, the Pretty Prairie Creek Road Dam, and Marsh Lake Dam, would not affect any buildings, but could cause road damage to Pretty Prairie Road and CR 900 E respectively. A break in the levee along the Wabash River near Americus would only cause damage to property or possibly crops.

Probability of Future Event

It is possible that portions of unincorporated Tippecanoe County could be affected by a dam failure in the future. The warning time associated with a dam failure is variable, in many historical dam breaks there was essentially no warning time. In other events, the warning time was significant enough to allow evacuation time prior to the break.

Communication between dam operators and downstream residents and emergency personnel is essential. The duration of the event is generally quick, but can produce long lasting societal impacts. The table below identifies the Calculated Priority Risk Index (CPRI) for a dam failure in this county.

Exhibit 39 Risk Index Dam

Calculated Priority Risk Index (CPRI) for Dam Failure					
	Probability • Unlikely • Possible • Likely • Highly likely	**Magnitude/ Severity** • Negligible • Limited • Critical • Catastrophic	**Warning Time** • > 24 hrs • 12-24 hrs • 6-12 hrs • < 6 hrs	**Duration of Event** • < 6 hrs • < 1 day • < 1 wk • > 1 wk	**CPRI**
Tippecanoe Co.	Possible	Critical	< 6 hrs	<6 hrs	2.5
Lafayette	Unlikely	Negligible	> 24 hrs	<6 hrs	1
West Lafayette	Unlikely	Negligible	> 24 hrs	<6 hrs	1
Battle Ground	Unlikely	Negligible	> 24 hrs	<6 hrs	1
Dayton	Unlikely	Negligible	> 24 hrs	<6 hrs	1
Clarks Hill	Unlikely	Negligible	> 24 hrs	<6 hrs	1

According to the CPRI, unincorporated Tippecanoe County is at risk to damage from dam failures. Other communities participating in this plan are unlikely to experience this hazard.

Vulnerability Analysis

A dam failure is most likely to affect the few areas of Tippecanoe County that are located downstream from dams, including the riverfront communities on Goldsberry Road and Morningside Lane. Because there have not been any past events in this county, there is no local historical information on this hazard. Nationally, past events have demonstrated that warning systems and communication are key to evacuation and saving lives. For this planning exercise only dry weather dam breaks were studied, in the future it would be beneficial to study this hazard during flooding conditions. Flooding is generally accompanied by heavy rain and could increase the potential for failure.

Analysis of Development Trends

A reasonable expectation would be that the need for critical facilities would rise with an increase in population. However, much of the area that is directly at risk of damage from a dam failure lies in the floodplain and Tippecanoe County prohibits construction in that area. Additionally, much of the area is located at the northern portion of the county line and major development of critical facilities is unlikely because there is no sewer or water service in that area.

The recent change in the Unified Zoning Ordinance that permits elevation of single-family homes in the floodplain could reduce the amount of property damage experienced by home owners in the event of a dam failure.

3.2.7 STAND ALONE UTILITY FAILURE

Massive utility failures can happen without being triggered by a natural disaster event such as a severe storm. In 2003 a massive utility outage in the eastern United States was caused by an energy company's failure to trim trees in Ohio. Strained high-voltage power lines went out of service when they came into contact with overgrown trees. This event was the largest blackout in North American history and affected an estimated fifty-five million people in the US and Canada. Outage-related financial losses were estimated at six billion dollars. A predecessor to the 2003 blackout was the 1965 northeast blackout, which left twenty-five million people without power for up to twelve hours.

Similar outages have also happened in European countries, including: England, Denmark, Sweden, and Italy. The cause of the 2003 London blackout, which

coincidentally took place just two weeks after the eastern US and Canada blackout, was a transformer fault caused by an oil leak. The oil leak had been previously detected, but not repaired. The London blackout ultimately affected far fewer people than the one in eastern US and power was restored much faster.

If a utility failure occurs during the winter, use of alternative heating sources is common. However, gas generators, grills or propane heaters can contribute to a build-up of deadly carbon monoxide gas in living areas. Caution should be exercised as people and animals can die from breathing this odorless, colorless gas.

Previous Occurrences

Based on local newspaper reports, there have only been minor utility failures in Tippecanoe County. The most recent occurred in May 2010 when about 2,500 people lost power in Tippecanoe and Benton Counties because of a failed stack insulator. Power was restored quickly and no negative effects were recorded. There was a minor failure in the Town of Battle Ground on May 3, 2004, which was caused by equipment failure. In June of that same year, thirty Purdue University buildings lost power for more than five hours. The event happened when a cable failed during repairs.

More commonly, utility failures occur when a construction company breaks a utility line. These events continue to occur despite an Indiana law requiring utility locating prior to digging.

Geographic Location

All areas of this county are subject to utility failures. Urban areas are at a higher risk because they have more infrastructure than rural areas. There are fifteen utility providers in Tippecanoe County.

Hazard Extent

The extent of damage from a stand-alone utility outage depends heavily on the conditions during which the failure happens. Damage associated with a failure could be exacerbated by the time of day, time of year and duration of the event. Loss of power during the summer triggers a loss of air conditioning and could lead to heat related illnesses for area residents, just as a loss of power during the winter leads to lack of heating and could trigger winter weather threats, such as hypothermia. Care facilities such has nursing homes and hospitals as well as police and fire facilities could

be greatly affected if back-up generators are not in place and if response plans have not been initiated.

Probability of Future Event

The probability of a stand-alone utility failure in unincorporated Tippecanoe County and the Town of Shadeland is possible, while a failure in the more urbanized cities and towns is likely. The magnitude or severity of such an event depends on the conditions in which it happens as well as the duration. The severity would be negligible in the unincorporated county and Shadeland and only limited in the three towns. An event could be critical in both Lafayette and West Lafayette, where the majority of critical facilities are located. The duration of an event is typically less than twenty-four hours and the warning time is virtually non-existent. The table below identifies the Calculated Priority Risk Index (CPRI) for a stand-alone utility failure in Tippecanoe County.

Exhibit 40 Risk Index Utility

Calculated Priority Risk Index (CPRI) for Stand-Alone Utility Failure					
	Probability • Unlikely • Possible • Likely • Highly likely	**Magnitude/ Severity** • Negligible • Limited • Critical • Catastrophic	**Warning Time** • > 24 hrs • 12-24 hrs • 6-12 hrs • < 6 hrs	**Duration of Event** • < 6 hrs • < 1 day • < 1 wk • > 1 wk	**CPRI**
Tippecanoe Co.	Possible	Negligible	< 6 hrs	< 1 day	2
Lafayette	Likely	Critical	< 6 hrs	< 1 day	3.05
West Lafayette	Likely	Critical	< 6 hrs	< 1 day	3.05
Battle Ground	Likely	Limited	< 6 hrs	< 1 day	2.75
Dayton	Likely	Limited	< 6 hrs	< 1 day	2.75
Clarks Hill	Likely	Limited	< 6 hrs	< 1 day	2.75

According to the CPRI, a stand-alone utility failure is likely in the Cities of Lafayette and West Lafayette and the Towns of Battle Ground, Dayton and Clarks Hill. Such an event is possible, but less likely in the unincorporated portion of the county and Shadeland.

Vulnerability Analysis

All of Tippecanoe County is at risk for stand-alone utility failure; however, failures are more likely to happen in the urban areas. Failures can affect water supplies, transportation, communications and industry. In some cases, they also caused civil disobedience such as looting, although no such event has occurred here.

Analysis of Development Trends

A reasonable expectation would be that the need for critical facilities would rise with an increase in population. As additional critical facilities are constructed, they too, will be exposed to potential damages from stand-alone utility failures.

4.0 COMMUNITY CAPABILITY ASSESSMENT

This section provides an inventory of existing mitigation efforts in Tippecanoe County. This capability assessment identifies measures that are currently in place, their success rate, and where gaps exist in efforts to mitigate the physical, social, and economic impacts of hazards.

4.1 NFIP PARTICIPATION

Tippecanoe County, Lafayette, West Lafayette, Dayton and Battle Ground are all members of the National Flood Insurance Program (NFIP). The table below lists each participant's NFIP number and the date they joined the program. The only non-NFIP community in Tippecanoe County is Clarks Hill, though town leadership has recently expressed an interest in pursuing membership. Shadeland became a member in late 2012.

Exhibit 41 NFIP Participation

NFIP Participation		
Community	**NFIP Number**	**Effective Date**
Lafayette	180253	November 19, 1980
West Lafayette	180254	January 2, 1981
Battle Ground	180252	January 2, 1981
Tippecanoe County	180428	March 16, 1981
Dayton	180486	February 12, 1982 (NSFHA*)
Shadeland	180603	November 1, 2012

*NSFHA = No Special Flood Hazard Areas

4.2 FLOOD INSURANCE CLAIMS

There are a total of 314 flood insurance policies in Tippecanoe County. As of 2014 a total of 319 claims have been made and $3,196,503 has been paid out through the NFIP for the entire county. **Table 4-2** is a summary of flood insurance policies and claims paid to each NFIP community.

Exhibit 42 Insurance Policies

Summary of Flood Insurance Policies and Claims		
NFIP Community	**Number of Policies**	**Total Payments**
Lafayette	76	$112,958
West Lafayette	22	$52,349
Battle Ground	7	$120,230
Tippecanoe County	214	$2,910,966
Dayton	NA	NA
Total	**319**	**$3,196,503**

(FEMA, 2014; IDNR 2014)

4.3 REVIEW AND EVALUATION OF EXISTING PLANS, PROGRAMS, AND PROJECTS

The Planning Committee discussed existing mitigation plans, programs, and projects in terms of the six mitigation measures used by FEMA: prevention, property protection; natural resource protection, emergency services, structural control projects, and public information. The following list gives a brief discussion of FEMA's mitigation goals as well as Tippecanoe County's existing plans and programs. This list of local programs is intended to be as comprehensive as possible at this time.

What value does mitigation have for my community?
Mitigation creates safer communities by reducing losses of life and property.

Mitigation enables individuals and communities to recover more rapidly from disasters.

Mitigation lessens the financial impact of disasters on individuals, the Treasury, state, local and tribal communities.

Source: FEMA.gov

Prevention

FEMA defines prevention as measures that are designed to keep the problem from occurring or getting worse. Member jurisdictions of the Area Plan Commission currently have long range planning, zoning, and subdivision ordinances that guide or restrict development from known hazardous areas. Shadeland has its own municipal code. All communities participating in this plan prohibit construction in the floodplain. Shadeland requires a 100′ setback from the floodplain boundary for new construction. All other jurisdictions require a 25′ no-building setback from the floodplain boundary and require that all structures built within the next 75′ to be at flood protection grade.

Local jurisdictions have tree trimming programs for street trees so that they do not become safety hazards. There is also a household hazardous waste collection site at the local Solid Waste District. The local subdivision ordinance also requires utility lines in new subdivisions to be buried, which prevents damage from different types of storms.

In early 2012, Tippecanoe County Officials decided to end their relationship with the Wildcat Creek Solid Waste District, instead partnering with Southside Landfill to run the Tippecanoe County Solid Waste District. It began accepting hazardous household chemicals in April 2012.

The US Forest Service defines **riparian buffers** as the aquatic ecosystem and the portions of the adjacent terrestrial ecosystem that directly affect or are affected by the aquatic environment. This includes streams, rivers, lakes, and bays and their adjacent side channels, floodplain, and wetlands. In specific cases, the riparian buffer may also include a portion of the slope that directly serves as streamside habitats for wildlife.

Property Protection

FEMA defines property protection as measures that are used to modify buildings subject to hazard damage rather than to keep a hazard away. The Unified Zoning Ordinance, adopted by all communities except Shadeland, requires all new mobile/manufactured home communities to include a tornado shelter for residents. Requiring an additional setback from the floodplain boundary helps ensure the future safety of buildings built near waterways should the floodplain change. The recent change in the Unified Zoning Ordinance that permits elevation of single-family homes in the floodplain could reduce the amount of property damage experienced by home owners in the event of a dam failure.

The City of Lafayette has established a well-head protection area for city wells.

Natural Resource Protection

FEMA defines natural resource protection as opportunities to preserve and restore natural areas and their function to reduce the impact of hazards. Tippecanoe County SWCD encourages agricultural landowners to implement filter strips along drainage ditches and riparian buffers along streams and rivers. The prohibition of the construction of walled structures in the floodplain also helps ensure the area is as natural as possible. Tippecanoe County, Lafayette, West Lafayette, Dayton, Battle Ground, Purdue University and Ivy Tech State College are MS4 communities and have adopted a stormwater ordinance to address sediment and erosion control as well as stormwater management measures. The new stormwater ordinance also includes a no

net loss in the floodplain component that requires compensatory storage for fill dirt added to areas in the floodplain. Shadeland was originally designated as an MS4 community, but is seeking an exception. They are responsible for stormwater ordinances within their jurisdiction. Clarks Hill is exempt from the MS4 requirements. The zoning ordinance only permits the storage of hazardous materials in certain zones by grant of a special exception from the Area Board of Zoning Appeals.

The Wabash River Enhancement Corporation implemented the first Phase of their Region of the Great Bend of the Wabash River Watershed Management Plan in 2011. This plan aims to reduce sediment and pathogen levels, improve stream habitat, and reduce the spread of invasive species.

Emergency Services

FEMA defines emergency services as measures that protect people during and after a hazard. Tippecanoe County has a county-wide outdoor warning system, but could benefit from additional sirens in certain areas. The TEMA office monitors weather systems in cooperation with IDHS using the National Weather Service and has additional subscriptions for weather monitoring services. The county has mutual aid agreements regarding weather monitoring services with all local jurisdictions as well as District 4, which includes all adjoining counties and Cass County.

There is also a state-wide agreement that allows the distribution of resources throughout the entire state during disasters. The county utilizes storm spotters during threatening weather. Local county officials and some area residents monitor water level changes on important streams using USGS gauge stations and field observations, water levels are monitored vigilantly in order to prepare for flood conditions. Local television and radio stations also carry weather warnings and advisories. The Red Cross has existing agreements to use area schools and churches as shelters during emergencies.

Community Organization Active in Disaster

Tippecanoe County is part of a nine county Community Organization Active in Disaster, (COAD). COADs help build capacity to respond to disasters by increasing social capacity. Tippecanoe County is part of the West Central Indiana COAD, (WCI COAD). The WCI COAD is a network of agencies and organizations, who prepare for, respond to and help recovery from disasters. While the WCI COAD is just a network, and needs growth, it helps Tippecanoe County be better prepared for disaster. The WCI has been active since 2013.

Structural Control Projects

Participating communities have stormwater detention and/or retention sizing requirements for new developments. Tippecanoe County also resizes culverts and bridges as resources allow.

> FEMA defines structural control projects as physical measures used to prevent hazards from reaching a property.

Public Information

There are several education and training programs throughout the county. MS4 communities, TEMA, SWCD, fire and/or police agencies and programs all have public information and education components. While some programs address hazards and methods of response, other programs focus on water-quality issues.

> FEMA defines public information activities as those that advise property owners, potential property owners, and visitors about the hazards, as well as ways to protect themselves and their properties from hazards.

Tippecanoe County's existing governmental structure ensures strong communication between various governmental agencies; this includes mutual aid agreements within the county and with surrounding counties, training for those interested in participating in emergency response and compatible GIS services for the many emergency response agencies. The existing zoning ordinance includes regulations that require safe rooms in mobile home parks (though no new mobile home parks have been developed since the ordinance took effect), restricts areas in which hazardous chemicals can be stored and prohibits development in the floodplain. The stormwater ordinance provides further protection to the floodplain by requiring compensatory storage for projects that include the addition of fill dirt to raise land above the regulatory flood elevation. Although the county's existing mitigation measures have many strong points, there are areas that can be improved. The on-line survey portion of this plan demonstrated that some area residents think access to fresh water, backup utilities and reliable communications would be most beneficial to the community. Additionally, a well-organized warning system for the upstream dams is a continued need to those residents living along the Tippecanoe River. Both the text of chapter five and its accompanying table are a comprehensive look at which mitigation measures could be improved and/or implemented by the county.

The CRS program credits NFIP communities a maximum of 30 points for reviewing and evaluating the effectiveness of existing activities as they relate to prevention, property protection, protection of natural resources, emergency services, structural control projects, and public information for flooding and other known natural hazards.

5.0 MITIGATION GOALS AND PROJECTS

This section identifies the mitigation goals and projects identified and evaluated by the MHMP Planning Committee for participating jurisdictions.

Section 5.1 lists the mitigation categories, projects, local status, local priority, benefit-cost ratio, project location, responsible entity, funding source, and hazard addressed as identified by the MHMP Planning Committee. The local status is categorized as "ongoing" and "proposed" and projects identified as such are expected to be completed within the 5-year term of this MHMP.

Depending on the availability of funding, some proposed mitigation projects may take longer to implement. The proposed projects have been organized in terms of the six mitigation goals (detailed description can be found in **Section 5.2**) used by FEMA: prevention; property protection; natural resource protection; emergency services; structural control projects; and public information.

Chapter 6 of this plan includes a discussion of completed projects.

The development and this update of the MHMP is a necessary step in the continuing implementation of programs, policies, and projects to mitigate the effects of hazards in Tippecanoe County. This planning effort had multiple intents:

- Identify the hazards which threaten this community;
- Identify to what extent they affect Tippecanoe County; and
- Identify mitigation strategies or projects that can be undertaken to mitigate the effects of the identified hazards.

This MHMP meets the requirements of DMA 2000 and eligibility requirements for the Hazard Mitigation Grant program (HMGP), Flood Mitigation assistance (FMA), Pre-

Disaster Mitigation (PDM) Grant, the Community Ratings System (CRS) as well as other FEMA programs. However, additional detailed studies will need to be completed prior to applying for grants or programs.

The CRS program credits NFIP communities a maximum of 72 points for setting goals to reduce the impact of flooding and other known hazards; identifying mitigation projects that include activities for prevention, property protection, natural resource protection, emergency services, structural control projects, and public information.

5.1 MITIGATION GOALS

The Planning Committee re-evaluated existing mitigation plans, programs, and projects in terms of the six mitigation measures used by FEMA: prevention; property protection; natural resource protection, emergency services, structural control projects; and public information. The committee also discussed the State's mitigation goals, which correspond with FEMA's six mitigation measures. Following the discussion, the Planning Committee decided on the following MHMP mitigation goals.

Prevention

- Manage the development of land and construction of buildings to reduce the impact of hazards on people and property; and
- Continue to prohibit construction of homes and other structures in known hazard areas, such as the floodplain.

Property Protection

- Prohibit building in known hazard areas such as the floodplain, steep slopes, brownfields, and areas with erodible soils;
- Regular inspections during construction to ensure that hazard protection standards are included in local code enforcement.

Natural Resource Protection

- Continue to preserve and maintain the function of existing natural resources to reduce the impact of hazards to people and property.

Emergency Services

- Improve the efficiency, timing and effectiveness of warning, response and recovery efforts before, during, and immediately after a hazard;
- Create an emergency warning system for residents living downstream from dams;
- Continue to train persons involved in emergency response in the National Incident Management System;
- Learn more about earthquakes risks and cascading effects; and
- Use new technology to help with hazard response and communication between different agencies.
- Use new technology for early warning and hazard alerts.

Structural Control Projects

- Prohibit structural control projects and remove existing structures in the floodplain so that it can function as naturally as possible.

Public Information

- Educate and inform the public about the risks of hazards and ways for citizens to protect themselves and their property before and during a disaster; and
- Use non-traditional or alternative communication networks during a disaster if traditional networks are inoperable.

5.2 MITIGATION PROJECTS

The Planning Committee reviewed FEMA's list of mitigation ideas for each hazard studied during this planning effort and identified which of those best meet the community's needs. All mitigation projects were evaluated according to selected social, technical, administrative, political, and legal criteria.

The following list includes the key consideration for each evaluation criteria:

- Social – mitigation projects will have community acceptance, they are compatible with present and future community values, and do not adversely affect or neglect any segment of the population;
- Technical – the mitigation projects will be technically feasible, reduce losses in the long-term, and will not create more problems than they solve;
- Administrative – the mitigation projects may require additional staff time, alternative sources of funding, and have some maintenance requirements;
- Political – the mitigation projects will have political and public support;

- Legal – the mitigation projects will be implemented through the laws, ordinances, and resolutions that are either in place or will be created to implement the goals of this plan.

Consistent with the last plan, a detailed economic and social analysis of each proposed project was beyond the scope and intent of this MHMP planning effort. However, the Planning Committee reviewed the projects and their potential benefits and costs associated with each project. During the pre-application phase of any grant request, a detailed benefit-cost analysis will be required. The committee reviewed each mitigation project's cost-to-benefit ratio.

The following projects include on-going projects, items not completed from the 2006 plan and new projects submitted by the planning committee, categorized by the six mitigation measures used by FEMA. Specific details on location, status, responsible entity and funding source for each project are identified in the sidebar next to each project category. A discussion of mitigation projects that have been completed since the last plan can be found in Chapter 6.

5.2.1 PREVENTION

Mitigation projects for prevention include land use planning and zoning, special projects and studies, floodplain management, geographic information services, safe rooms and community shelters, community ratings system, safety procedures for hazardous materials, tree maintenance, and utilities.

Land Use Planning and Zoning

- Incorporate the 2015 update of the Multi-Hazard Mitigation Plan into the Comprehensive Plan for Tippecanoe County. The Comprehensive Plan is a powerful planning tool for mitigation because it defines how and where the community should grow. Goals and objectives identified in the Comprehensive Plan are the foundation for all development ordinances in the community.
- Continue restriction of activities in the floodplain; continue compensatory storage requirements and prohibition on construction.
- Encourage innovative planning tools and ideas such as updating The Park, Recreation and Open Space element of the adopted Comprehensive Plan, cluster development, the development of greenways, alternative pavement products and conservation easements to limit and/or modify development in known hazard areas.

STATUS
On-going
LOCAL PRIORITY
High
BENEFIT/COST RATIO
High
LOCATION
Tippecanoe County
and all NFIP Communities
RESPONSIBLE ENTITY
APC
FUNDING SOURCE
Existing Budget
HAZARDS ADDRESSED
Dam Failure
Flooding

Watershed-based Projects and Studies

- Conduct special projects and studies such as hydrology and hydraulic modeling and watershed management planning in known hazard areas to better understand conditions and identify solutions. Support, with continued staff participation, the Wabash River Enhancement Corp.'s (WREC) 319 Watershed Plan for the Region of the Great Bend of the Wabash River watershed.

STATUS
On-going

LOCAL PRIORITY
High

BENEFIT/COST RATIO
High

LOCATION
Tippecanoe County

RESPONSIBLE ENTITY
APC, Surveyor, Purdue, City Engineering Departments

FUNDING SOURCE
Existing budgets & grants

HAZARDS ADDRESSED
Dam Failure
Flooding

Floodplain Management

- Continue the prohibition on the construction of walled structures in the floodplain, current requirements for no adverse impact in the floodplain, and participation in the Indiana Association of Floodplain and Stormwater Managers.
- Participation in the Indiana Risk Map Program to enhance existing mitigation planning efforts.
- Continue to seek grants to buy out homes located in the floodplain to help reduce risk to life and property damage for local residents.
- Encourage the town of Clarks Hill to join the NFIP.

STATUS
On-going

LOCAL PRIORITY
High

BENEFIT/COST RATIO
High

LOCATION
Tippecanoe County and communities with floodplains and flooding

RESPONSIBLE ENTITY
APC, County Surveyor, all jurisdictions

FUNDING SOURCE
Existing budgets and grants

HAZARDS ADDRESSED
Dam Failure, Flooding

Geographic Information Services

- Incorporate local data into the HAZUS-MH database to replace the national data set so that model predictions will be more accurate and specific to Tippecanoe County. This will need to be done each time the MHMP is updated.

STATUS
Proposed & on-going
LOCAL PRIORITY
Local use: High
HAZUS: Medium
BENEFIT/COST RATIO
High
LOCATION
Tippecanoe County

RESPONSIBLE ENTITY
APC, Lafayette, MITS
FUNDING SOURCE
Existing budgets & Grants
HAZARDS ADDRESSED
Dam Failure, Earthquake, Flooding, Utility Failure, Tornado & Windstorm, Hazardous Materials

Safe Rooms and Community Shelters

- Encourage safe rooms in private homes and apartment buildings/complexes as well as mobile home communities throughout the county and partner jurisdictions. The warning time associated with many hazards such as earthquake, tornado or windstorm is minimal.
- Require safe rooms in all new public facilities, which are generally centrally located and are occupied by a large number of people. Safe rooms may also be required in multi-family structures without a safe location such as a basement. While a basement is better than no shelter, the National Weather Service encourages a safe room located within a basement to better protect individuals from structural collapse.
- Clearly mark the location of safe rooms and shelters for both building occupants and visitors.

STATUS
On-going
LOCAL PRIORITY
High
BENEFIT/COST RATIO
High
LOCATION
Public buildings, multi-family buildings, public parks

RESPONSIBLE ENTITY
APC, City Engineers
County Building Commissioner
FUNDING SOURCE
Existing budgets
HAZARDS ADDRESSED
Dam Failure, Flooding, Earthquake, Hazardous Material, Severe Winter Storm, Tornado & Windstorm, Utility Failure

Community Ratings System (CRS)

- Continue to encourage NFIP communities in Tippecanoe County to 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 rates are discounted to reflect the reduced flood risk.

STATUS
On-going
LOCAL PRIORITY
High
BENEFIT/COST RATIO
High
LOCATION
All NFIP Communities

RESPONSIBLE ENTITY
APC
FUNDING SOURCE
Existing budget
HAZARDS ADDRESSED
Flooding

Tree Maintenance

- Continue tree maintenance in road rights-of-way, utility corridors, and public property. Regular maintenance of trees improves the health and longevity of public trees as well as reduces the potential for dead or dying limbs from falling and injuring people, damaging property, and utility lines during a tornado, windstorm, or severe winter storm.

STATUS
On-going
LOCAL PRIORITY
Low
BENEFIT/COST RATIO
High
LOCATION
All public property, ROW and utility corridors in the county

RESPONSIBLE ENTITY
Tipmont, Duke, Parks Dept.
FUNDING SOURCE
Utility rate or existing budgets
HAZARDS ADDRESSED
Severe Winter Storm, Tornado & Windstorm, Utility Failure, Flooding

5.2.2 PROPERTY PROTECTION

Mitigation projects for property protection include techniques for protecting buildings as well as property insurance.

Building Protection

- Continue to prohibit the construction of all buildings and critical facilities, in known hazard areas. Access to and from medical care, police, fire, emergency operation centers, power substations, potable water, and wastewater treatment facilities must be maintained during, and following, a hazard event. Other types of critical facilities such as schools and government building are occupied by a large number of people who could become trapped if built in a hazard area.

STATUS On-Going	**RESPONSIBLE ENTITY** APC, Tipp. Co. Grant Coordinator
LOCAL PRIORITY Prohibit Constr: High Acquisition: Medium	**FUNDING SOURCE** Existing budget, property owners, Grants (PDM, FMA, HMGP)
BENEFIT/COST RATIO High	**HAZARDS ADDRESSED** Dam Failure, Earthquake, Flooding, Hazardous Material, Severe Winter Storm, Tornado & Windstorm, Utility Failure
LOCATION All residential & non-residential structures	

- Actively pursue buyout money for properties located in the floodplain. This money could be used for acquisition and relocation, and would help reduce the high costs of response and recovery associated with flood events.

Property Insurance

- Continue encouragement to property owners in known hazard areas to purchase property and multi-hazard insurance (such as flood insurance) to protect their investment. Although insurance should not be considered an alternative to mitigating damages for any type of hazard, it does protect property owners from financial devastation if damage does occur.

STATUS On-going	**RESPONSIBLE ENTITY** APC, City Engineers
LOCAL PRIORITY High	**FUNDING SOURCE** Existing budget, property owners
BENEFIT/COST RATIO High	**HAZARDS ADDRESSED** Flooding, Dam Failure, Earthquake, Hazardous Material, Severe Winter Storm, Utility Failure, Tornado & Windstorm
LOCATION All bldgs. in known Hazard areas	

Building Codes

- Review construction standards and building codes to ensure that hazard protection standards, especially for critical facilities and structures (such as mobile homes) which are anchored by "tie downs", are incorporated into local building codes and inspections and to ensure that those codes are sufficient. Continue enforcement of adopted building codes in all jurisdictions. Building codes are an important mitigation measure for flooding, earthquake, tornado, windstorm, and severe winter storms. This may include sprinkler systems, structural bracing, anchor bolts, and secured exterior materials such as roofing shingles and shutters.

STATUS
On-going
LOCAL PRIORITY
High
BENEFIT/COST RATIO
High
LOCATION
All buildings in the county, especially those in known hazard areas

RESPONSIBLE ENTITY
APC, City Engineering
FUNDING SOURCE
Existing budget
HAZARDS ADDRESSED
Flooding, Dam Failure, Utility Failure, Earthquake Tornado & Windstorm, Hazardous Material, Severe Winter Storm

5.2.3 NATURAL RESOURCE PROTECTION

Mitigation projects for natural resource protection include land use planning and stormwater management.

Natural Resource Planning

- Continue to restrict development in the floodplain and encourage "No-Adverse Impact" (NAI) techniques, promoted by the Association of State Floodplain Managers (ASFPM).
- Protect natural wetlands from encroaching development and agricultural activities. Wetlands serve as natural collection basins for floodwaters. Acting like sponges, wetlands collect water, filter it, and release it slowly into rivers and streams. Protecting and preserving wetlands can help prevent flooding.

STATUS
On-going
LOCAL PRIORITY
Floodplain: HIGH
Wetland: MEDIUM
Stormwater: HIGH
BENEFIT/COST RATIO
High
LOCATION
All communities

RESPONSIBLE ENTITY
APC, City Engineers, MS4 coordinator
FUNDING SOURCE
Existing budget
HAZARDS ADDRESSED
Flooding

Stormwater Management

- Continue to encourage Best Management Practices (BMPs) as identified in the Stormwater Quality Management Program (SWQMP) that address construction and post-construction site stormwater runoff control.

STATUS
On-going

LOCAL PRIORITY
High

BENEFIT/COST RATIO
High

LOCATION
All NFIP Communities

RESPONSIBLE ENTITY
City Engineers, Purdue, and County Surveyor

FUNDING SOURCE
Existing budget

HAZARDS ADDRESSED
Flooding

5.2.4 EMERGENCY SERVICES

Mitigation projects for emergency services include mutual aid agreements, emergency warning systems, and power back-up systems.

Mutual Aid Agreements

- Annually review, maintain and continue to utilize the mutual aid agreements between neighboring communities and counties to ensure a quick response to an incident or in the event of a hazard. Mutual aid agreements can be expanded to include utility and communication services in addition to fire protection. Tippecanoe County participates in the state-wide mutual aid agreement. Encourage development of a mutual aid agreement between all law enforcement departments/ agencies within the county and those in neighboring jurisdictions.

STATUS
On-going

LOCAL PRIORITY
High

BENEFIT/COST RATIO
High

LOCATION
TEMA and all police and Fire departments in Tippecanoe County

RESPONSIBLE ENTITY
TEMA and Red Cross

FUNDING SOURCE
Existing budgets

HAZARDS ADDRESSED
Flooding, Dam Failure, Earthquake, Hazardous Materials, Severe Winter Storm

Emergency Warning Systems

- Utilize All Hazards outdoor warning systems and extend their coverage as populations expand to alert the residents of a potential tornado, severe weather event or other hazard. Advance warnings such as sirens, in conjunction with Emergency Alert System broadcasts, are an effective mitigation measure to reduce loss of life and property. It is important to note that warning sirens are only designed to alert those out of doors of a potential hazard. The general public should continue to be encouraged to have multiple warning devices and avenues of obtaining information.

STATUS
On-going & proposed

LOCAL PRIORITY
Sirens, Dams, NOAA Radio, Communication: HIGH
Stream Gauges, USO Amendment: MEDIUM

BENEFIT/COST RATIO
High

RESPONSIBLE ENTITY
TEMA, IDNR, USGS

FUNDING SOURCE
Existing budgets & Grants

HAZARDS ADDRESSED
All

LOCATIONS
Sirens needed in Americus and Clarks Hill; Stream gauges needed on the Wea, Indian, and Burnett's Creeks; All critical facilities and new development in Tippecanoe County; All emergency response facilities, personnel and vehicles.

- Utilize stream gauges as well as the USGS website for flood warning. NOAA Weather Radio and the EAS broadcast can be incorporated into the community's flood warning system.
- Ongoing cooperation with dam operators and owners with early warning systems for dam facilities and excessive water release. Continue partnerships with dam operators and early warning systems.
- Encourage purchase of NOAA weather radios to all critical facilities and train personnel on use of radio. Encourage residents and businesses to stay aware of current weather conditions with NOAA Weather Radios.
- Maintain a redundancy of communication systems to ensure clear communication with emergency personnel before, during, and after a hazard.
- Work with the development community to install all hazards warning sirens in growth areas of the community.

Power Back-Up Generators

- Encourage emergency back-up generators at all critical facilities in known hazard areas because back-up power is vital; traffic signals should be included as facilities that need back-up power. Ham radio operators should also be included in this because this group could be vital during emergencies if traditional communication lines are no longer available.

STATUS
Proposed
LOCAL PRIORITY
Critical Facilities: HIGH
Traffic Signals: MEDIUM
BENEFIT/COST RATIO
High
LOCATION
All critical facilities, major Intersections

RESPONSIBLE ENTITY
Property owner, TEMA, Parks & Street Dept.
FUNDING SOURCE
Construction and operating costs for building owners
HAZARDS ADDRESSED
Dam Failure Earthquake Flooding, Hazardous Materials, Severe Winter Storm, Tornado & Windstorm, Utility Failure

Hazard Database

- Collect and report accurate and community specific information on hazard events, including extent, magnitude, and costs to each community. Keeping a detailed, up-to-date, and consistent record of hazards in a central location will help keep the future planning process efficient and relevant.

STATUS
Proposed
LOCAL PRIORITY
Medium
BENEFIT/COST RATIO
High
LOCATION
County-wide documentation of hazard impacts for grants and updating this plan

RESPONSIBLE ENTITY
APC, TEMA
FUNDING SOURCE
Existing budget, Grants
HAZARDS ADDRESSED
ALL

5.2.5 STRUCTURAL CONTROL PROJECTS

Mitigation projects for structural control projects include requirements for high hazard dams and drainage systems.

Stormwater Drainage Improvements

- Installing, re-routing, or increasing the capacity of a storm drainage system that can involve detention and retention ponds, or drainage easements along streams and creeks can improve flood mitigation.
- Continued maintenance of waterways traversing through public lands to prevent localized flooding by removing debris such as large log jams. The risk of flooding increases when drainage systems are not properly maintained.
- Create regional detention solutions for appropriate waterways; typically county-regulated drains in urban areas

STATUS
Proposed
LOCAL PRIORITY
Medium
BENEFIT/COST RATIO
High
LOCATION
All new developments required to comply with stormwater ordinance.

RESPONSIBLE ENTITY
County Surveyor, City Engineering, Purdue
FUNDING SOURCE
Existing budgets, grants
HAZARDS ADDRESSED
Flooding

5.2.6 PUBLIC INFORMATION

Mitigation projects for public information include education and outreach projects.

Public Education and Outreach Projects

- Participate in community events, such as local neighborhood meetings and area school activities, throughout the year to share information on the different types of hazards, methods for preventing damages resulting from hazardous conditions, locations of safe shelters and how to respond when a hazard threatens.

STATUS
On-going
LOCAL PRIORITY
High
BENEFIT/COST RATIO
High
LOCATION
Schools, community events, Public buildings, MS4 communities

RESPONSIBILE ENTITIY
TEMA, Red Cross, Police and Fire, and Parks Depts.
FUNDING SOURCE
Existing budgets & grants
HAZARDS ADDRESSED
All

- Maintain literature regarding hazards in public facilities, such as libraries, government office buildings, police and fire stations as well as on government websites. FEMA publishes information on different aspects of hazards, including methods to prevent damage and response techniques.
- Continue to update literature and online resources for hazards or events specific to Tippecanoe County that are not covered by existing FEMA publications or where local regulations differ from national ones (for instance, floodplain management and logjam removal).
- Implement the Best Management Practices (BMP) identified in the county stormwater ordinance that addresses public education, outreach, participation, and involvement.

6.0 GOALS UPDATE MAINTENANCE PROCEDURES

This section of the plan describes how Tippecanoe County officials and offices will ensure that the plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and a revision every five years. This section describes how jurisdictions will incorporate the mitigation strategies and goals outlined in this plan into existing planning mechanisms and procedures.

Many of the mitigation projects and goals include on-going and continued efforts to reduce run-off, prohibit development in the flood plain and encourage innovating planning tools such as "green" development, riparian buffers and pervious paving materials. The following outlines updates and measurable progression. The Planning Committee has reviewed the 2006 Mitigation Projects & Goals and heard reports from responsible parties. The following is a list of Tippecanoe County's hazard mitigation accomplishments since 2006.

<u>Area Plan Commission</u>

- Five properties have utilized buy-out grant money since 2006;
- The county's GIS coordinator has added data to more effectively model hazards in the HAZUS program;
- Staff's certified flood plain manager has received additional training in HAZUS modeling software in summer 2011 and FEMA training in summer 2014;
- Digital zoning maps were adopted;
- Continued efforts have been made to encourage NFIP communities to join the CRS program to reduce flood insurance premiums.

<u>County Surveyor</u>

- Currently completing a hydrologic study of the Indian Creek watershed;
- Digital Flood Insurance Rate Maps have been adopted;
- Continues to encourage buy-out grants;
- Encourages Clarks Hill to join the NFIP. The Office of Community and Rural Affairs (OCRA) has grant money to study and enhance drainage infrastructure in rural communities that experience overland flooding;

- The County's Comprehensive Stormwater Management Ordinance has been updated and approved by the County Commissioners (Ordinance 2011-27-CM);
- Over five miles of ditches and drains have been cleaned out along CR 450 E & 500 S.

TEMA

- A mutual aid agreement is in place between neighboring communities to ensure quick response in the event of an emergency;
- Outdoor warning systems are continually updated and maintained. TEMA is not looking into expanding coverage but investigating other ways of notifying the public of an emergency. Three new sirens were added since the last plan; there are 71 total sirens in the county.
- TEMA has a plan in the event of a dam failure;
- One of TEMA's strategic goals is to encourage the public to stay informed of severe weather and hazardous events. Every county in Indiana is receiving 60 weather radios to distribute to low-income households;
- The county has two communication systems that operate independently to maintain redundancy;
- TEMA's Emergency Operations Center was recently completed and will improve communications and accommodate the needs of emergency personnel following a disaster. This would include updating the meeting area with an adequate number of table and chairs so that a large group of decision makers could be accommodated;
- Community Corrections currently has a back-up generator and having one for all critical facilities is an on-going concern;
- Applying for grant money to revitalize the CERT training program.

6.1 ONGOING PLAN MANTENANCE

The Area Plan Commission staff and the Executive Director of TEMA will reconvene the MHMP Planning Committee annually during the five year planning cycle of this document. In preparation for the annual meeting, the appropriate APC staff member and TEMA's Executive Director will meet to review the mitigation strategies and to prepare a list of items accomplished as well as those that are in progress or have yet to be started. These individuals will then prepare a report of upcoming work items to present to the Planning Committee. At each annual meeting, the Committee will monitor, evaluate, and update the Plan as needed. Members of the Committee can meet to discuss the Plan between meetings when necessary.

6.2 GOALS MAINTENANCE AND IMPLEMENTATION

The mitigation process table, the hazard database and changes to local ordinances as well as public input will help the Committee evaluate the plan in terms of its effectiveness. At the annual meetings, the Committee may determine the plan needs to be changed or updated to increase effectiveness. APC staff will make all changes and updates to the plan. Prior to submitting the plan to the IDHS and FEMA, members of the planning committee will review the final document. At the end of the five year period, the updated plan will be resubmitted to the state and federal agencies by APC staff.

6.2.1 HAZARD DATABASE

A goal of the initial plan was to create a hazard database that was updated as needed so that new information regarding disaster events can easily be added to the plan update. The database will enable the committee (as well as individual communities) to keep track of financial losses resulting from several events to assist future planning. This database will be monitored and maintained by both the APC and TEMA offices, with APC staff making the updates. This will continue to be a goal.

6.2.2 MITIGATION PROCESS TABLE

Outlined in the first plan was a goal for a mitigation process table to be created and maintained so that the information needed to update the plan will be readily available. This would allow the Committee to keep track of the status of each project and assist in providing direction for future initiatives. The table will be created after this plan's update that will keep track of the mitigation process and opportunities for mitigation projects. Available funding and a record for each project will be kept accordingly.

6.2.3 ZONING ORDIANCE UPDATES

Zoning ordinance updates benefiting all six member jurisdictions will also be added as needed and records of the changes will be kept by APC staff.

This is the first update of the MHMP prepared by Tippecanoe County and NFIP communities; data used was the best information readily available during the planning process. There could be limitations based on current data and updates with new, more accurate data is expected and planned for. During the annual committee meetings, updates to the risk assessment and vulnerability analysis will be made as appropriate based on newer data.

6.3 INCORPORATION INTO EXISTING PLANS

Several of the proposed mitigation projects are currently on-going, but are in need of enhancements. Existing planning documents adopted by the jurisdictions represented in this plan will be amended to reflect necessary changes.

GIS data needed for hazard analysis, including data needed for HAZUS-MH, will be updated throughout the five year planning cycle by the County GIS Department as time allows.

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.

7.0 REFERENCES

WWW. FEMA.GOV

WWW.WILDCATCREEK.ORG

FEMA 2002. State and Local Mitigation Planning How-to Guide. September 2002, FEMA 386-1.

U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration

APPENDIX A—NOTES AND AGENDAS FROM MEETINGS

Area Plan Commission of Tippecanoe County
Multi-Hazard Mitigation Plan
Planning Committee Meeting

10am-12pm Friday March 25, 2011
Community Corrections Building
2800 N 9th Street Road

AGENDA

1. Introductions
2. Overview of the 2006 Plan
3. Update and Identify Critical Facilities
4. Progress Report on Mitigation Projects
5. Next Planning Committee Meetings
    a. April 29, 2011 10a.m. – 12 p.m.
    b. May 27, 2011 10 a.m.-12 p.m.

Area Plan Commission of Tippecanoe County

Multi-Hazard Mitigation Plan

PLANNING COMMITTEE MEETING

10:00 a.m. – 12:00 p.m.
March 25, 2011
Community Corrections Building
2800 N 9th Street Road

MEETING SUMMARY

In Attendance:
Sallie Fahey, APC Executive Director
Ryan O'Gara, APC Assistant Director
Larry Aukerman, APC Planner, Certified Floodplain Manager
Bianca Klinker, APC Planner
Charlie Williams, Tippecanoe County Sheriff's Department
Brian Bugajski, City of Lafayette
Mark Ehle, Tippecanoe County GIS Coordinator
David Downey, West Lafayette Sanitation
Heather Philhower, American Suburban Utilities
Mike Spencer, Tippecanoe County Highway
Dave Byers, Tippecanoe County Commissioner
Zach Beasley, Tippecanoe County Surveyor
Marty Webb, TEMA
Smokey Anderson, TEMA
Tilara Treece, Tippecanoe County Health Department & LEPC
Beth Cook, West Lafayette City Engineer's Office

Carol Shelby, Purdue University
Bob Wollenburg, Red Cross
Tim Rytlewski, Evonik Industries

1. Introductions

Sallie Fahey introduced APC staff members working on the 2011 MHMP update. The rest of the group introduced them and identified which agency they represent.

2. Overview of 2006 Multi Hazard Mitigation Plan

Sallie explained that the last plan, created in 2006, is part of our Comprehensive Plan and was adopted by all member jurisdictions except Shadeland. The MHMP, required by the Disaster Mitigation Act of 2000, identifies what we can do as a community to reduce impacts of disasters on property and personal safety. The plan includes data collection about past disaster and hazard events, list of hazards that the planning committee decided was pertinent to our community and methodology from FEMA to analyze the impact of hazards (including severity, frequency, likelihood and duration). In this update, the Committee needs to decide if the same hazards should be studied or if any new hazards are applicable. Additionally, we will develop projects that will mitigate those hazards.

The Planning Committee will meet monthly on or about the 4th Friday.

3. Update and Identify Critical Facilities

Sallie said that FEMA provides some guidance regarding what is a critical facility and quoted the definition found in the 2006 MHMP:

> *"A critical facility is a structure that, if damaged, would present an immediate threat to life, public health and safety. Essential facilities include hospitals, facilities that produce, store or transport toxic material and emergency operation centers. Eligible private nonprofit facilities may receive funding under the following conditions: the facility provides critical services which include power, water, sewer services, wastewater treatment, communications, emergency medical care, fire department services, emergency rescue and nursing homes."*

The Plan also identifies public and private facilities that are not essential but could require assistance with evacuation.

Larry Aukerman presented a power point with maps and lists of identified critical facilities in 2006.

Airfields

The group reviewed the ten listed airfields in Tippecanoe County. The airfields were located on the map. Discussion followed regarding whether the listed airfields were still in use; it was decided that all airfields except Aretz still exist.

Zach Beasley mentioned that there is an airfield that crosses a legal drain on the south side of SR 28 between 300 E and 400 E. Smokey Anderson concurred.

Sallie stated that staff would locate that airfield and add it to the list.

Bus Stations

There was discussion that the Depot should include the Greyhound facility as well as CityBus. There were questions as to why the Mayflower Transit Company was included on the list.

Smokey Anderson asked if it was really a critical facility.

The group discussed whether Lafayette Limo should be included because their vehicles may serve to evacuate in the event of a hazard.

Marty Webb stated that there is no contract in place with Lafayette Limo and any agency to use their vehicles to evacuate.

Lafayette Limo will not be included as a critical facility.

Tim Rytlewski asked if the location of school bus facilities should be listed because those can be used for evacuation.

Several members agreed and Sallie said those locations will be added to the map.

Communications

Ryan O'Gara noticed that TV-18 WLFI is not included in the list and should be added.

Smokey Anderson mentioned TEMA communications are located in Murdock Park and at the Purdue Water Tower. The State Police Post transmission tower at SR 43 and 600 N is also critical to EMS communication.

Tilara Treece asked if there should be a difference between station and tower location because some towers are on the station site.

Bianca Klinker asked about locating cell phone towers.

Smokey noted that if the backup generators on cell phone towers fail, we have to protect all locations identified in the plan.

Sallie said we could think about whether or not to include cell phone towers.

Dams

Mike Spencer pointed out that the Tippecanoe County Highway Dam is called the Marsh Lake Dam. He also noted that the Robert Franklin Pond Dam is now located in Prophetstown.

Smokey asked if the committee should classify these dams as critical. He mentioned that many of them are small and in rural areas and would not cause much damage if they failed.

Marty suggested adding levees to this list. He mentioned there is a large levee that was constructed by a farmer that stretches along the Wabash from 675 E to 900 E along the Wabash. There are also levees around the sewage treatment plants in both cities.

Smokey said there was a Deer Creek Levee that was built with federal money in the 1930s.

David Downey added that both sewage treatment plant levees should be added.

Sallie agreed that the levees are an important addition. The main reason the dams were included is because failure would cause considerable road damage; especially the Pretty Prairie Road and Marsh Lake to Pretty Prairie Road and CR 900 E. Additionally, the 2006 plan indicates that failure of the Treece Lake Dam would affect 15 residences and cause approximately $2 million in damage.

Fire Stations

Marty pointed out that Wabash Township VFD Station #1 is located on Klondike

between US 52 and SR 26 and Wabash Township VFD Station #2 is on Newman Road.

David Downey noted that WLFD has two stations.

Tilara Treece said that LFD Station #5 is not noted on the list as Station #5 but there is an icon in its approximate location.

Bianca Klinker mentioned that LFD Station #4 should be included as a government building as it houses administrative functions. She asked if Evonik has a Fire Department.

Tim Rytlewski said they have their own equipment and a verbal mutual aid pact with Shadeland.

Sallie said Evonik's FD should then be added to the list and asked if anyone knew whether some of the other big industries have their own FDs.

Marty noted that both Caterpillar and Alcoa have fire brigades but does not know if their equipment ever leaves their sites.

Sallie added staff will check if they have equipment and whether it can be utilized.

Tim Rytlewski asked if any of these locations house ambulances.

Marty said the WLPD Station #5 has ambulances.

Carol Shelby mentioned Purdue FD also has ambulances.

Sallie stated we can create a symbol that denotes Fire Department with Ambulances.

<u>Hospitals</u>
The group noted that the list should be amended as follows;

1. Franciscan Alliance St. Elizabeth Health – Lafayette Central
2. Franciscan Alliance St. Elizabeth Health – Lafayette East
3. IU Clarian Arnett
4. Unity Building 1
5. Unity Building 2
6. River Bend Hospital

Sallie asked if there was a new mental health facility opening near Park East. She said staff would investigate. She also asked if there were other locations that had overnight capabilities.

David Byers mentioned the location of Arnett on Summerfield and Concord.

Bob Wollenburg suggested that facilities with overnight capabilities might fit better in the "Other Care Facilities" category.

Military

The location of the new armory was shown in the 2006 plan; there have been no other changes.

Brian Bugajski added that LPD will have a presence at the old Army Reserve building on South Street.

Tim Rytlewski said we should add TEMA equipment locations.

Other Care Facilities

Dave Byers noted the new senior housing development at US 52 & Klondike

Tilara Treece said Creasy Springs and the Fowler House should be added. She suggested LUM (Lafayette Urban Ministry).

Marty said that if you add LUM, churches would have to be added as they sometimes will house people overnight. He also mentioned that by listing these facilities in the plan, that means TEMA has to provide services in the event of a disaster. He said that if you include too many critical facilities, TEMA cannot get to them all.

Sallie said that was a very important piece of information. She said that staff will review the guidelines established for creating the plan and will keep that in mind.

Marty said that it is useful for emergency services to know locations of these types of facilities, but they don't have to be listed as essential facilities. He added that he feels that power and water companies should be critical.

Zach Beasley added that it is also important to include the Highway Garage and both Cities' transportation centers.

Sallie agreed and reiterated that staff will check with plan guidelines.

Potable Water
Marty suggested water tower locations should be added to the list.

Carol Shelby mentioned that the Purdue Water Tower should also be included.

Heather Philhower noted that American Suburban has a small water treatment facility for about 200 customers.

Marty asked if Evonik's water tower needs to be on the list.

Tim Rytlewski asked if the criteria for including potable water sources included "IDEM permitted" water sources or just a public source.

Sallie said staff would check on that definition and criteria. She also mentioned staff would investigate where all of the current public water sources are located.

Railyards
Marty pointed out that the railyard labeled as "Staley's North" is a Norfolk-Southern Railyard.

Sallie also mentioned that the name should not be Staley's but Tate & Lyle.

Wastewater Treatment Plants
Sallie asked if there are any new treatment plants.

Smokey mentioned Romney's new treatment plant, but noted that it pumps to Linden.

Sallie speculated that is the same reason Dayton's plant is not on the list, because it pumps to Lafayette. She agreed that neither Romney nor Dayton's plant should be included.

Hazardous Material Handlers
Carol Shelby mentioned that LEPC has a list of all hazardous materials handlers.

Sallie said that is a good resource and we should use that list.

Smokey noted that locations that handle batteries no longer need to be included.

Marty asked if pipelines and bulk gas distributors are on the list.

Sallie asked if bulk gas distributors like LPD's station are on the list.

Dave Byers mentioned that some trucking companies and agricultural co-ops have large gas storage tanks. Pat Scowden at Weights & Measures should have a list.

Smokey also mentioned Ceres Solutions on SR 28.

Marty said he could get the list of pipelines and distributors from the Department of Homeland Security.

Brian Bugajski said that we should add the future Nanshan site to the list.

Heather Philhower pointed out that neither Vectren or Duke were on the list.

Tim Rytlewski said that the name Eli Lilly needed to be changed to Evonik.

Marty also noted that Ice Cream Specialties and Hanson Cold Storage have a lot of ammonia and should be considered a hazardous materials handler.

Sallie said staff will double check this list with the list LEPC has.

Schools

Zach Beasley mentioned Wyandotte and Woodland elementarys are new.

Mark Ehle added that the new Ivy Tech Downtown location should be considered on the list.

Tim Rytlewski asked if New Community School has multiple sites.

Brian Bugajski said that Faith Baptist also has the new community center and school.

Dave Byers noted that Battle Ground now has two elementary schools.

Zach Beasley mentioned locations of a few daycares of which he is aware. He asked how large daycares need to be before they are included as a critical facility.

Sallie responded that staff will investigate the threshold for daycares as critical facilities.

Tilara Treece mentioned the location of the alternative school at the old Elston building.

Brian Bugasjki asked if LARA should be included at the old Washington School and the Tippecanoe County Childcare locations.

Bianca Klinker mentioned Wabash Center should be added.

Larry Aukerman asked if there are any adult daycare locations.

Mark Ehle said he could use the GIS layer he created for the sex offender exclusion zones.

4. **Progress Report on Mitigation Projects**

Sallie asked the Committee if they would like to put off Agenda Item 4 until next meeting or go ahead and progress, as it was nearing 11:30.

The group agreed to start this discussion at the next meeting.

5. **Next Planning Committee Meetings**

Sallie said that with TEMA's concurrence we have scheduled the following meetings: April 29 and May 27.

The group agreed to cancel the May 27 meeting because it is the Friday before Memorial Day and added meetings on June 3 and June 24.

Area Plan Commission of Tippecanoe County Multi-Hazard Mitigation Plan Planning Committee Meeting

10am-12pm Friday April 29, 2011
Community Corrections Building
2800 N 9th Street Road

AGENDA

1. Critical Facilities Mapping
    a. Critical vs. Essential Facilities

    b. Answers from previous meeting

2. Progress Reports on Mitigation Projects

3. Hazard Identification

4. Next Planning Committee Meetings

    a. June 3, 2011-- 10a.m. – 12 p.m.

    b. June 24, 2011 -- 10a.m. – 12 p.m.

Area Plan Commission of Tippecanoe County Multi-Hazard Mitigation Plan

PLANNING COMMITTEE MEETING

10:00 a.m. – 12:00 p.m.
April 29, 2011
Community Corrections Building
2800 N 9th Street Road

MEETING SUMMARY

In Attendance:
Sallie Fahey, APC Executive Director
Ryan O'Gara, APC Assistant Director
Larry Aukerman, APC Planner, Certified Floodplain Manager
Bianca Klinker, APC Planner
Charlie Williams, Tippecanoe County Sheriff's Department
Brian Bugajski, City of Lafayette
Mark Ehle, Tippecanoe County GIS Coordinator
David Downey, West Lafayette Sanitation
Heather Philhower, American Suburban Utilities
Dave Byers, Tippecanoe County Commissioner
Zach Beasley, Tippecanoe County Surveyor
Smokey Anderson, TEMA
Tilara Treece, Tippecanoe County Health Department & LEPC
Beth Cook, West Lafayette City Engineer's Office
Tim Rytlewski, Evonik Industries
Mike Francis , West Lafayette Police Department

Mike Blann, Lafayette Fire Department
Tom Rankin, Lafayette Parks Department
Stan Lambert, Wabash River Enhancement Corporation

1. Critical Facilities Mapping

Larry Aukerman presented the updated map of critical facilities. He said that every category of critical facilities has been mapped except care facilities. He suggested that the easiest way to deal with daycares and nursing homes is to combine them into one group called "care facilities." He mentioned that he is waiting on information from LEPC regarding hazardous materials handlers. He also said that the biggest challenge is how to display the maps.

Sallie Fahey mentioned that we could display the maps by jurisdiction or by section. She explained that we will present the maps in the most understandable format. She thinks that by jurisdiction makes the most sense, but that if anyone has a preference to let staff know.

Larry pointed out that we will also include the street addresses of all mapped critical facilities. In the previous plan, only the locations were shown.
Sallie added that if the location of any critical facilities should not be known for security reasons, let staff know.

Donna Majewski pointed out that the State gives LEPC a spreadsheet for all HazMat handlers and we can easily import that data into GIS.

Sallie mentioned that we should probably keep the whereabouts of chemicals out of the public knowledge.

Donna added that chemical storage locations are also on the EPA's website.

Larry moved on to ask if cell phone towers should be included as critical facilities.

Smokey said that if one tower goes down, communication likely won't be affected because they have overlapping coverage areas. He added that if the whole cellular system goes down, that would be a problem.

Sallie asked wasn't that why HAM radio operators volunteer in case of an emergency?

Smokey answered that is the case, but most of their towers are also on the cell phone towers.

Sallie suggested we map only EMS towers because those need special protection.

Smokey agreed. He said if EMS can't get the message about a hazard event out via TV or radio, then that mode of communication is critical. If emergency services can't communicate, that would be bad but EMS does not rely solely on cell phones.

Sallie clarified that critical communication facilities for the public include the TV and radio stations; critical communication facilities for EMS are their own towers.

Larry pointed out on the map that there are currently 12 towers mapped. He said that adding EMS towers will bring the total up to 15 or 16.

Sallie added that we will continue to work on how best to display the maps.

Bianca Klinker mentioned that a question arose at the last meeting about water sources and whether the ones that we included as critical facilities were permitted or just public sources. Staff has decided that we only need to include public sources, so Caterpillar's or Evonik's water towers do not need to be included in the list of critical facilities.

Sallie asked if Purdue has their own wells.

Smokey said that he was not sure, but thought they did.

Sallie said that staff will look into whether Purdue has its own well fields.

David Downey added that Purdue has its own wells but also uses Indiana American, too.

Sallie thought that someone in facilities would have the answer.

Bianca also pointed out that at the last meeting there was a question regarding including daycares in the critical facilities and what the threshold for inclusion was. She explained the handout with FEMA's definition of critical and essential facilities. Staff has decided to include only the 43 or so daycares that are large enough to be listed in the phonebook.

Dave Byers asked about Otterbein and whether they were included in our MHMP since half is in Tippecanoe County and half is in Benton County.

Sallie answered that for planning purposes, the town is under Benton County's jurisdiction but staff will check. If Otterbein is not included in their MHMP, we can decide whether to include them in ours.

Sallie also added that there has been growing interest on the part of FHWA regarding how we protect our transportation assets and mitigate for climate change hazards. In this community, we're going to be most affected by flooding. It might make sense for this group to look at bridges and evacuation routes that are vulnerable to flooding. She added that she's just posing this idea to the committee to think about. We can combine an element of transportation planning into this document; including established routes for evacuation and coming up with ideas in this plan for mitigating these routes. Also, we should think if there is anything we could do to enforce safety on bridges.

2. Progress Reports on Mitigation Projects

APC

Incorporate hazard mitigation goals into the Comp Plan (P1a) –*MHMP was adopted into the Comprehensive Plan*

Continue restriction on development in the flood plain (P1b, P3a, PP1a & NR1a)—*Ongoing*

Update FP ordinance to reflect county's stormwater ordinance (P1c) –*completed*

Encourage innovative planning tools like updating park plan, cluster development, greenways, alternative paving materials & conservation easements (P1d) —*Ongoing*

Hydrology and hydraulic modeling, watershed management, continued cooperation and participation in the CTPP (P2a) —*Ongoing*

DFIRMS (P3b)—*completed*

Actively pursue buy-out grants (P3c & PP1b)—*Continuing*

Encourage Shadeland and Clarks Hill to join NFIP (P3d)—*Staff needs to make another presentation to Clarks Hill about the benefits of joining the NFIP*

Incorporate local data into HAZUS-MH database for better modeling specific to Tippecanoe County (P4a)—*Mark Ehle added that we can add data to match the specifications of HAZUS modeling.*

Update HAZUS with local data at parcel level rather than Census Tract (P4c)—*We plan on completing this after Larry Aukerman attends training in Indianapolis at the beginning of May.*

Additional training for staff in HAZUS (P4d)—*Larry is attending HAZUS training*

Create GIS zoning maps with accurate FP info (p4e)—*Continuing to work towards this. We hope to have digital zoning adopted.*

Establish safe rooms in vulnerable locations (P5a)—*We have not done much work on safe rooms. However, in the UZO, safe rooms are required for all new mobile home parks but we have not had any new MHPs since the adoption of NUZO in 1998.*

Require safe rooms in new public facilities (P5b)—*Not sure anyone has worked on this goal. Sallie added that she doesn't think there have been any new public facilities except schools since 2006.*

Encourage NFIP communities to participate in the NRS program to reduce flood insurance premiums (P6a)—*We've started working on participation in the Community Rating System (CRS), but it's a laborious process.*

Encourage property owners in the FP to buy flood insurance (PP2a)—*Continuing*

Encourage "No Adverse Impact" techniques promoted by the ASFPM (NR1a)—*Ongoing*

Protect wetlands from encroaching development (NR1b)—*APC makes sure development does not occur in wetlands as shown on the National Wetlands Inventory.*

Sallie also mentioned that the more things we can "check off" in the Community Ratings Program, lower our score and we can positively affect flood insurance premiums.

TEMA

Smokey reported on the mitigation goals accomplished and still ongoing.

Utilize mutual aid agreements between neighboring communities and counties to ensure quick response in event of hazard (ES1a)—*In place*

Conduct Mutual Aid Capability Verification to assess availability of resources and response time for emergences (ES1b)—*Smokey said this was a non-issue with the state's mutual aid agreement.*

Utilize outdoor warning systems and extend coverage (ES2a)—*Ongoing with maintenance. He said TEMA is not looking to expand the existing warning system, but investigating other methods of communication with the public.*

Utilize stream gauges as well as USGS website for flood warnings (ES2b)—*Do this already*

Work with dam operators and owners to create an early warning system (ES2c)—*Currently do this on the Tippecanoe River. The dam operators have a plan and Tippecanoe County is included in the plan.*

Encourage residents & businesses in known hazard areas to get a NOAA radio and stay on top of hazard events and conditions (ES2d)—*One of TEMA's four strategic goals is to courage people to stay informed. Every county in Indiana is getting 60 weather radios and we will distribute to low-income households.*

Maintain redundancy of communication (ES2e)—*Do this already. We have two communication systems that operate independently.*

Require emergency back-up generator at all critical facilities in known hazard areas; this includes HAM operators (ES3a)—*Community Corrections has an emergency generator, but it is an ongoing concern for the Red Cross.*

Sallie added that when the mapping of critical facilities is completed, we will know which facilities are in known hazard areas.

Upgrade the facilities and communication network at the EOC (ES4a)—*Working on an upgrade*

Collect and report accurate info on community specific events; keeping an up-to-date and consistent record of hazards (ES5a)—*LEPC's list of Tier II reporting sites fulfills some of this goal.*

Seek additional funding for CERT (ES6a)—*The CERT program had languished. But we have a class now and are hoping to revitalize the program. We have applied for grant money to purchase additional equipment.*

COUNTY SURVEYOR

Zach Beasley updated the group on the Surveyor's mitigation goals.

Hydrology and hydraulic modeling, watershed management, continued cooperation and participation in the CTPP (P2a)—*Currently working on with the Indian Creek watershed. He added they might do a study with the Drainage Board.*

Continue prohibition on construction of walled structures in FP & participation in the Indiana Assoc of FP & Stormwater Managers (P3a)—*Ongoing*

DFIRMS (P3b)—*Completed*

Actively pursue buy-out grants (P3c & PP1b)—*Ongoing. He mentioned he recently spoke with a property owner along Indian Creek who was interested in the buy-out program.*

Encourage Shadeland and Clarks Hill to join NFIP (P3d)—*He has been talking to Clarks Hill and been working on their participation. The Surveyor's Office has been working on a regulated drain that runs through Clarks Hill that needs some improvement. We have received some OCRA grant money that was set aside to enhance drainage infrastructure of small towns that have a high flood possibility*

Smokey asked if the drain would be cleaned out.

Zach answered that Clarks Hill is served by an old clay subsurface tile. He added that it wasn't designed for drainage and runoff, but to lower the water table for farming. He wants to get money to increase the tile to handle runoff or create an open ditch. The biggest issue is getting consent from landowners; a lot of farmers don't want to give up land to create an open ditch. He said the process is in the early stages but we have a list of property owners and income levels which is a requirement of the grant. He added it's a long process but OCRA is optimistic and it would be good for Clarks Hill.

Implement Best Management Practices (BMP) identified in the Stormwater Quality Management Program that addresses construction and post-construction stormwater runoff control (NR2a & PI1d)—*Ongoing. The Stormwater Development Ordinance is almost complete. The Ordinance also addresses Low-Impact Development and gives developers ideas to follow for green construction.*

Installing, re-routing or increasing capacity of storm drainage system to include retention ponds and drainage easements along streams and creeks (SC1a)—*Ongoing*

Maintain waterways traversing through public lands on a regular basis to prevent localized flooding by removing debris (SC1b)—*Five miles of ditches have been cleaned out and dredged on 450 E, south of 500 S.*

Regional detention solutions (SC1c)—*This is part of watershed management and ongoing studies.*

WEST LAFAYETTE ENGINEERING

Beth Cook said that as far as she knows, Jeromy Grenard had started increasing capacity of the sewer system and protecting wetlands.

Sallie asked isn't that the intent of the Stormwater Ordinance and isn't it multi-jurisdictional?

Zach said that it does cover all jurisdictions.

GIS

Mark Ehle said that he is working on additional HAZUS training.

TIPPECANOE COUNTY GRANT COORDINATOR

Dave Byers, speaking on behalf of Laurie Wilson said that the approximate time frame for the buy-out program is four years. He said two buyouts have been completed.

Sallie asked if we're still matching funding.

Dave responded that the Commissioners have the money set aside in the budget for buy-outs.

Sallie suggested that additional fees could be added to permits from raising flood-damaged homes to put into the match fund for the buy-out programs.

Dave agreed and said that $5 could be added to those permits to help the program.

SOIL AND WATER CONSERVATION DISTRICT

Sallie asked if Zach could comment on how the Soil and Water Conservation District is implementing Best Management Practices (BMPS).

Zach said that they're very aggressive in putting in soil and vegetation to prevent erosion. SWCD has worked with the County Commissioners to put in rain gardens with the County Cow Barn at the Fairgrounds. They have lots of programs to implement BMPs like rain barrels, rain gardens and pond clean up days.

WABASH RIVER ENHANCEMENT CORPORATION

Stan Lambert added that WREC has just completed a master plan for the whole river. He added WREC has received a 319 grant for watershed management, another grant to implement BMPs, and a final grant to create a watershed management plan for Sugar Creek and Deer Creek. He mentioned that the rural river corridor plan will focus on ecosystem restoration and preserving wetlands. WREC is moving towards addressing BMPs.

3. Hazard Identification

Larry explained that the committee needs to decide which hazards to study.

Sallie said that we can look at the existing hazards and decide which ones we want to continue to study or not study. She said that expansive soils might be one to look at more closely. She asked Zach if he agreed.

Zach responded that we could make the argument that they're worthwhile, but not a huge deal. He questioned the threshold of hazards to study. He said that some dams are very small, but CR 900 E itself is a dam holding back the Big Fish N Campground pond and is starting to erode.

Sallie said that is already an identified dam so it can be dealt with under the dam section. She asked if wildfires should be added.

Smokey said that during the hot of summer, fields of corn will burn but he asked how one mitigates field fires.

Sallie said that burn bans can be a prevention measure. She added that we didn't study drought, heat and hail because those events are cyclical and seasonal. Heat isn't a serious issue here and we lumped hailstorms in with tornadoes and windstorms.

Bianca Klinker asked about Purdue's nuclear reactor.

Smokey said that it generates enough energy to power one light bulb.

Sallie said that now the committee needs to determine the probability of each of these hazards occurring. We will look at probability of occurrence, magnitude, warning time and duration.

Hazardous Material Spill

Smokey asked how the warning timeframe was developed.

Sallie said that the warning times of >24 hrs, 12-24 hrs, 6-12 hrs and <6 hrs were standards given to us by FEMA. Sallie said staff will investigate those time periods.

Mike Blann said that the duration of chemical hazards is less than one week.

Smokey added that warning time for these hazards is sometimes less than one minute.

Flood

Dave Byers asked what the warning time for a flood is, suggesting about 6 hours.

Smokey responded that we typically have more warning than that, unless it's a flash flood or levee/dam break.

Zach Beasley stated that he is okay with a 6 hour warning time.

Sallie reiterated that staff will investigate the source of warning timeframes.

Tornado/Windstorm

Smokey said that warning time for a tornado could be more than 6 hours.

Charlie Williams asked if the duration meant "the event" or the aftermath, too.

Sallie explained that duration means just the time of the event, not clean up. She asked if less than 6 hour duration was agreeable.

Everyone agreed.

Winter Storm

Smokey asked how we are measuring magnitude. He said that a tornado will affect limited area versus a snow storm that may shut down the whole state. He added that he thinks snow storms are the only hazard (other than an earthquake) that could affect the entire county at one time.

Sallie said that we will change the magnitude of winter storms to catastrophic.

Ryan O'Gara asked about the possibility of a succession of events, like multiple storms and then power outages that would cause a longer duration.

Charlie Williams pointed out that the options of duration are either one day or one week with no in-between.

The group reminisced about the 1978 blizzard and 1991 ice storm.

Tom Rankin said that while the 1991 storm was an overnight event, people in Lafayette were without power for a week; that was catastrophic.

Charlie Williams asked if that scenario was the worst case or the average.

Sallie mentioned that this committee had the same discussion in 2006, but went with the norm not the exceptional events.

Ryan O'Gara added that the duration of storms is less than one week.

Earthquake

Dave Byers asked if our area is really highly likely to experience an earthquake.

Smokey said that it is guaranteed we will have an earthquake, but it could be 1,000 years until the "big one." We have a 40-50% chance in 40 years for a 5.0 magnitude earthquake, 8% chance of a huge one.

Sallie added that is why earthquakes are listed as "highly likely."

Smokey agreed that it should remain "highly likely."

Ryan O'Gara said that he would downgrade it to "likely."

Smokey reiterated that earthquakes are highly likely, but maybe not the possibility of a bad one.

Tom Rankin said that he leans towards "likely." He asked about tremors.

Sallie said those are lumped in with earthquakes.

The group agreed to keep the likelihood of earthquakes as "highly likely."

Dam Failure

Dave Byers thinks dam failure likelihood should be moved to "possible" or maybe "unlikely."

Ryan asked about historic failures.

Sallie mentioned that there are private dams which were not constructed well or maintained. We will move the likelihood to "possible."

Larry Aukerman added that if we experienced a NIPSCO dam failure, there would still be a lot of people in Tippecanoe County affected.

Sallie asked if everyone was okay with the severity level of "critical." She added that NIPSCO only models wet weather failure, not sunny day failure. But the possibility of sunny day failure is very small. In wet weather failure, we'll have at least 6 hours warning time.

Smokey said that the consequences of a wet weather failure are worse because the river is already flooded.

Utilities

Sallie said that these are separate events from power outages associated with storms, which explains why the scores were very low.

Everyone agreed.

4. Next Planning Committee Meeting

June 3, 2011 10 a.m.-12 p.m.

Area Plan Commission of Tippecanoe County

Multi-Hazard Mitigation Plan
Planning Committee Meeting

9 am Friday July 24, 2015
TEMA Office-Basement
629 N. 6th Street

AGENDA

1. Plan Update-Overview of Changes
2. Planning Committee Comments
3. Approval Process

MEETING SUMMARY

In Attendance:

Mary Russell-Shadeland
Paul Smith-Clarks Hill
Martin Web-TEMA DHS
Carol Shelby-Purdue University
Steve Egly-Battle Ground
Sallie Fahey-APC

Larry Aukerman-APC
Kathy Lind-APC
Ryan O'Gara-APC
Steve Butram-Lafayette Fire
Stan Lambert-WREC

Sallie Fahey explained that Indiana Department of Homeland Security, (IDHS) got Tippecanoe County a grant to have the Polis Center complete analysis for GIS work and plan review.

Larry Aukerman explained that the major changes that have taken place in the last year are Shadeland's participation in the plan and the Polis Center Analysis.

Larry explained that the Polis Center will review the plan before its submission to FEMA.

Larry stated that the entire County of Tippecanoe is now included in the plan other than the portion of the Town of Otterbein located in Tippecanoe County.

Martin asked why Otterbein is excluded from the plan.

Sallie stated that Otterbein should be included in the Benton County MHMP.

Larry gave an overview of the plan hazard by hazard.
A discussion followed regarding the analysis of plume and tornado path locations.

Larry explained that the focus of the plan is mitigation that can take place before a hazard.

Sallie asked Mary for information about Shadeland and what preventative measures they have in place. Mary will get Larry information in the next few weeks.

Sallie talked to Paul about Clarks Hill joining the NFIP. Mary said she could guide Paul through the process because she guided Shadeland through the process.

Marty's comments from summer 2014 were included in the existing plan.

A discussion by the committee commenced regarding requiring additional severe weather sirens as part of the plan. The committee agreed that it would look more into requiring sirens in the next plan.

Sallie explained that one of the goals is an annual meeting of the committee to keep the plan in our schedule.

Sallie again explained the adoption process for the plan.

APPENDIX B--PUBLIC PARTICIPATION

PUBLIC SURVEY

RESULTS FOR QUESTION 1 – PUBLIC SURVEY

1. At your property in Tippecanoe County, have you ever experienced any of the following disasters (select all that are appropriate)?

Disaster	Responses	Percent
Earthquake	9	27.3
Snow Storm	27	81.8
Wind Storm	19	57.6
Dam Failure	0	0
Ice Storm	18	54.5
Utility Failure	18	54.5
Flood	7	21.1
Tornado	9	27.3
Hazardous Spill	2	6.1

Other: Lightning, None

2. What time of year did these events occur?

Disaster	Spring	Summer	Fall	Winter	Don't remember
Earthquake	1	1	0	5	0
Snow Storm	0	0	25	1	0
Wind Storm	6	6	2	0	3
Dam Failure	0	0	0	0	1
Ice Storm	1	0	0	16	1
Utility Failure	1	5	2	1	8
Flooding	2	1	1	1	2
Tornado	5	2	0	0	1

Hazardous Spill	0	0	1	0	0

3. What year did these events occur?

Disaster	2006	2007	2008	2009	2010	2011	Don't remember
Earthquake	0		1	1	1	1	5
Disaster	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Don't remember**
Snow Storm	0	0	1	0	5	6	8
Wind Storm	1	0	0	2	2	5	5
Dam Failure	0	0	0	0	0	0	1
Ice Storm	1	0	1	0	2	3	8
Utility Failure	0	0	1	0	0	5	7
Flooding	0	0	0	2	1	1	2
Tornado	2	0	0	0	0	2	2
Hazardous Spill	0	0	0	0	0	0	2

4. Extent of Damage

Disaster	None	Up to $2,999	$$3,000-$9,999	$10,000 or more	Don't remember
Earthquake	8	0	0	0	0
Snow Storm	18	3	0	0	0
Wind Storm	7	8	2	0	0
Dam Failure	1	0	0	0	0
Ice Storm	12	5	0	0	0

Utility Failure	7	4	0	0	0
Flooding	2	1	1	0	0
Tornado	4	1	0	2	0
Spill	1	1	0	0	0

5. Where did the damage occur?

Lafayette	12 (40%)
West Lafayette	15 (50%)
Battle Ground	1 (3.3%)
Dayton	1 (3.3%)
Clarks Hill	1 (3.3%)
Shadeland	0 (0%)

6. Which disasters apply most to your current residence?

Earthquake	12 (32.4%)
Snow Storm	34 (91.9%)
Wind Storm	33 (89.2%)
Dam Failure	0 (0%)
Ice Storm	34 (91.9%)
Utility Failure	21 (56.8%)
Flooding	9 (24.3%)

Tornado	29 (78.4%)
Hazardous Spill	3 (8.1%)
Other: Lightning	

MEDIA RELEASE

For Immediate Release-Public Participation Meeting August 5, 2015, 5:00 PM
Contact: Larry Aukerman or Sallie Fahey, Area Plan Commission of Tippecanoe County
(765) 423-9242; laukerman@tippecanoe.in.gov or sfahey@tippecanoe.in.gov

Lafayette, IN (July 24, 2015) – The Federal Disaster Mitigation Act of 2000 (DMA 2000) requires communities to prepare a Multi-Hazard Mitigation Plan, (MHMP) in order to be eligible for future mitigation funding through the Indiana Department of Homeland Security and the Federal Emergency Management Agency. The intent of the planning process is to prepare for a disaster before it occurs to reduce the physical, social and economic impact of that disaster. The disasters most likely to occur in this community were analyzed for severity, duration, warning time, extent and potential damage. These disasters include: hazardous materials, flooding, tornados/windstorm, severe winter storm, earthquake, dam failure and utility failure.

To ensure the future flow of money to our community, the Area Plan Commission, in cooperation with the Tippecanoe County Emergency Management Agency and on behalf of Tippecanoe County, Lafayette, West Lafayette, Battle Ground, Clarks Hill, Dayton, and Shadeland has prepared a draft Multi-Hazard Mitigation Plan. The plan identifies ways to lessen the impact of disasters on our community and ways to reduce loss of life and property when a disaster does strike.

Citizen input is a key element of the planning process and the resulting outcomes. According to Larry Aukerman, APC staff, "Additional information or ideas based on personal experiences with dam failures, earthquakes, flooding, severe snowstorms, tornadoes, ice storms, hazardous material spills, and utility failures would be particularly helpful because some of the best lessons come from experience."

Local governments have some existing mitigation tools in place; the plan calls for the preservation or expansion of existing measures while adopting new initiatives. Examples of existing mitigation tools:
1. The Area Plan Commission and its member jurisdictions have prohibited construction in the floodplain since 1965; the Town of Shadeland also prohibits construction in the floodplain.
2. In 1998, the Unified Zoning Ordinance began requiring under ground tornado shelters for new manufactured home communities. This concept could be expanded for places of public assembly, apartment complexes or manufacturing plants.
3. Use of NOAA weather radios at critical facilities, such as hospitals and by residents in known hazard areas, would reduce risk to citizens and property by providing additional time to seek shelter and secure belongings.

Tippecanoe Emergency Management Agency Director, Smokey Anderson said, "If we can minimize risk by deploying the hazard mitigation tools identified in the plan we help keep citizens, their property and emergency responders safer."

The Area Plan Commission is now inviting the public to comment on the draft version of the MHMP, which is available online at the Tippecanoe County Area Plan Commission website homepage at www.tippecanoe.in.gov/apc and in print at the Area Plan Office. **A public**

meeting to discuss the draft plan will be held on August 5, 2015, at 5:00 pm in the Tippecanoe Room of the Tippecanoe County Office Building located at 20 N. 3rd Street. Public comment will be received from now until August 6th, 2015 and can be mailed to the Area Plan Commission, 20 N. 3rd Street, Lafayette 47901 or emailed to Larry Aukerman at laukerman@tippecanoe.in.gov

---END----

Area Plan Commission of Tippecanoe County

Multi-Hazard Mitigation Plan
Public Meeting

5 pm August 5, 2015
Tippecanoe County Office Building
20 North 3rd Street, Lafayette, IN

AGENDA

1. Plan Overview
2. Public comment
3. Explanation of Approval Process

In Attendance:

John Swick
Sallie Fahey
Jackson Bogan
Kathy Lind
Carl Griffin

Rabita Foley
Tim Shriner
Jay Seeger, APC Atty.
Gerry Keen
Tom Murtaugh
Gary Schroeder
Vicki Pearl

Sallie gave an overview of the plan; she explained that FEMA requires a meeting for public input.

The draft plan has been on the website for several weeks.

Sallie spoke to WLFI, (local TV station), about posting an article on their webpage.

Next she explained the approval process with FEMA.

Sallie explained that the POLIS Center completed the analysis and Shadeland is participating in the MHMP.

All jurisdictions in the county are participating except Otterbein because it will be included in Benton County's MHMP.

The plan's focus is on what the county can do to help minimize hazards before they happen.

The planning committee decided to study the following hazards: dam failure, earthquake, flood, severe winter storms, tornado, wind storm, hazardous material storage and transport, and standalone utility failures.

Sallie discussed each hazard briefly. Next she briefly described the proposed plans and projects.

Sallie opened the floor for public comments--No comments.

Media Reports for Public Input meeting.

wlfi.com

News From Where You Live

Public able to give input on hazard mitigation plan

Kelley Roberts
Published: July 20, 2015, 4:55 pm I Updated: July 20, 2015, 5:10 pm

Flooding could cost farmers millions in crop losses. (WLFI Photo)

Tippecanoe County, Ind. (WLFI)-For the first time in nearly a decade, Tippecanoe County's multi-hazard mitigation plan will be presented to the public.

A public meeting will be held Aug. 5 after the Executive Area Plan Commission meeting.

The plan is a joint effort by the APC and emergency management to outline the risks this area faces, like floods and tornados, as well as address what steps officials are taking to minimize potential damage.
There will also be time for public input.

The executive meeting begins at 4:30 p.m. at the Tippecanoe County Building. For a draft of the plan, click **here.**

The last time the plan was presented to the public was in 2006.

POWER POINT FROM PRESENTATION

TIPPECANOE COUNTY MULTI-HAZARD MITIGATION PLAN (MHMP)

ADDITIONS TO PLAN IN THE LAST YEAR

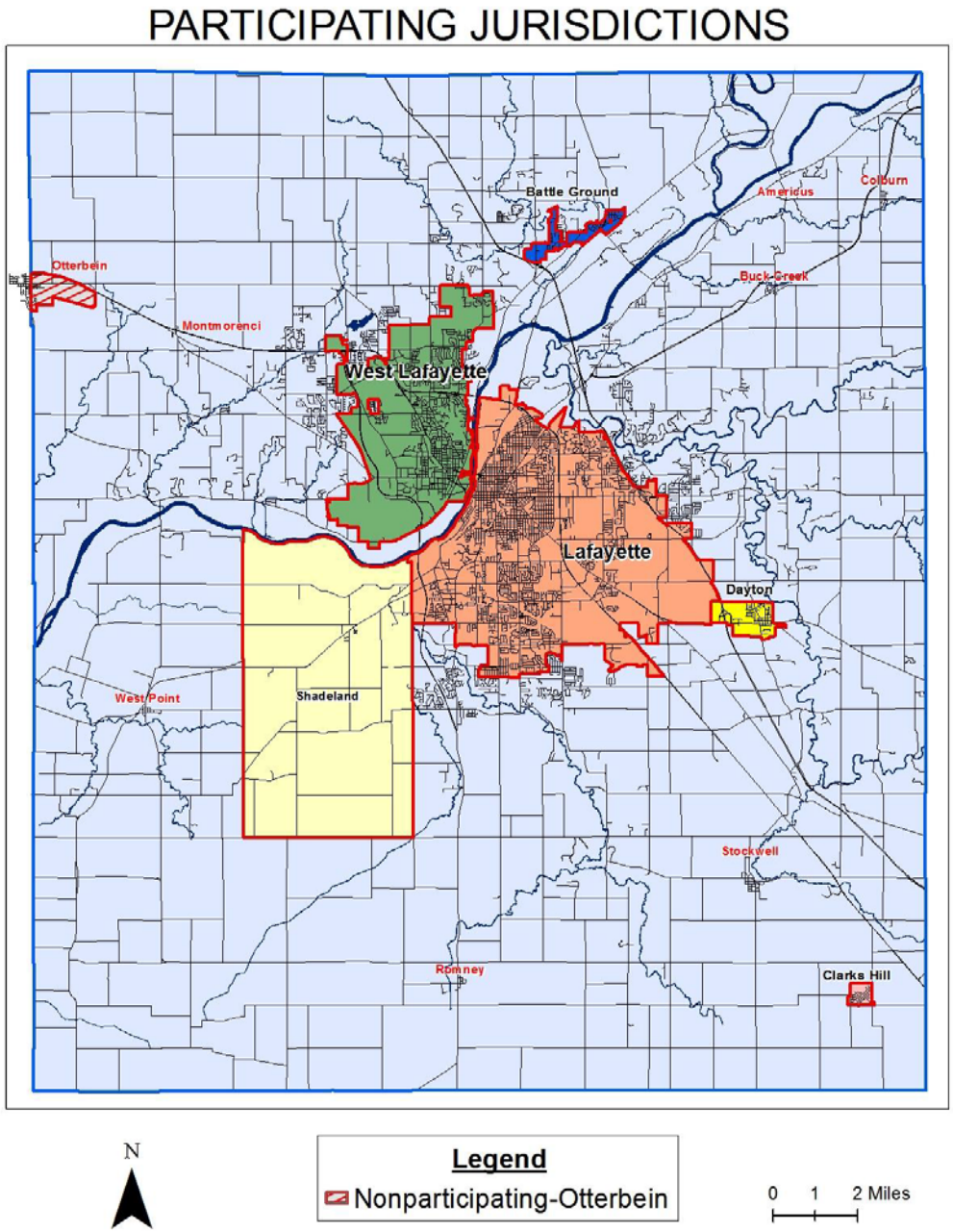
- SHADELAND IS NOW PARTICIPATING IN PLAN
- POLIS CENTER HAZUS ANALYSIS

ABOUT THE PLAN

- Requirement of the Federal Disaster Act of 2000
- Adoption of this plan and required updates ensure that the communities involved will be eligible for future federal disaster assistance as well as federal buyout money.
- It also enables the communities to apply for a variety of grants, such as Hazard Mitigation Grants (HMG), to implement projects to reduce damages.

PARTICIPATING JURISDICTIONS

- Lafayette
- West Lafayette
- Battle Ground
- Dayton
- Clarks Hill
- Unincorporated Tippecanoe County
- Shadeland



MITIGATION GOALS AND PROJECTS

- <u>FEMA'S SIX MITIGATION GOALS</u>

  1. PREVENTION
  2. PROPERTY PROTECTION
  3. NATURAL RESOURCE PROTECTION
  4. EMERGENCY SERVICES
  5. STRUCTURAL CONTROL PROJECTS
  6. PUBLIC INFORMATION

Hazards Discussed by the Planning Committee

This table illustrates the hazards discussed and those the planning committee chose to study in depth. Hazards that were studied are shown in bold and include:

Earthquake;

Flood;

Severe winter storm (including ice);

Tornado;

Windstorm;

Hazardous materials (storage and transport); and

Utility failure (not weather related).

Hazards Discussed by the Planning Committee		
List of Hazards	**Hazards with Local Impact**	**Hazards for Detailed Study**
Avalanche	No	
Coastal Erosion	No	
Coastal Storm	No	
Dam Failure	Yes	Yes
Drought	Yes	No
Earthquake	**Yes**	**Yes**
Expansive Soils	No	
Extreme Heat	Yes	No
Flood	**Yes**	**Yes**
Hailstorm	Yes	No
Hurricane	No	
Land Subsidence	No	
Landslide	No	
Severe Winter Storm (ice)	**Yes**	**Yes**
Tornado	**Yes**	**Yes**
Tsunami	No	
Volcano	No	
Wildfire	No	
Windstorm	**Yes**	**Yes**
Hazardous Materials (storage & transport)	**Yes**	**Yes**
Ebola Outbreak	**Yes**	**No**
Utility Failure (gas, sewer, water, electricity)	**Yes**	**Yes**

APPENDIX C—ADDITIONAL DATA

Email From FEMA for repetitive loss data

From: Schein, David <David.Schein@fema.dhs.gov>
Sent: Wednesday, July 01, 2015 12:17 PM
To: Larry Aukerman
Cc: lkannapel@dnr.in.gov; Smith-Kuypers, Laurie; Schein, David; McCarthy, Julia
Subject: RE: repetitive loss structures

Importance: High

Here is your requested info:

REPETITIVE LOSS
West Lafayette 1 property w/2 payments (structure and contents); $3,492 total
Lafayette none

SEVERE REPETITIVE LOSS
West Lafayette 2 properties; one with 3 claims (all structure)for $56,120 total; the other with 4 claims (all structure)for $79,127 total; both of these appear to be substantially damaged if your floodplain ordinance contains a cumulative substantial/rep/loss requirement, and this last property appears to have met the single-time substantial damage threshold in 2011 alone.
Lafayette 1 property with 5 claims (all structure) for $115,677; This structure appears to be substantially damaged if your ordinance contains the language noted above.
Further details require a Privacy Act Routine Use request; Let me know if you require addresses, which must be protected from disclosure. If you do not have the requisite Request template I can send one.

Thanks\\David Schein, Regional Flood Insurance Liaison
Floodplain Management and Insurance Branch
Mitigation Division
FEMA Region V Chicago
312 408 5539

From: Larry Aukerman [mailto:laukerman@tippecanoe.in.gov]
Sent: Tuesday, June 30, 2015 1:13 PM
To: Schein, David
Subject: FW: repetitive loss structures

Mr. Schein:
Can you tell me the number of repetitive loss structures in Lafayette and West Lafayette?
I need to include this data in the update of the Hazard Mitigation Plan.

Thanks,
Larry

Larry Aukerman, CFM
Current Planner
Area Plan Commission of Tippecanoe County
20 North 3rd Street
Lafayette IN 47902
Office (765) 423-9242
laukerman@tippecanoe.in.gov

From: Kannapel, Laura [mailto:lkannapel@dnr.IN.gov]
Sent: Tuesday, June 30, 2015 2:11 PM
To: Larry Aukerman
Subject: Re: repetitive loss structures

Please contact Mr. David scheme at David.schein@fema. He will be able to give you the information! I do not have access to that.

Sent from my iPhone

On Jun 30, 2015, at 10:24 AM, Larry Aukerman <laukerman@tippecanoe.in.gov> wrote:

Ms. Kannapel:
Can you tell me the number of repetitive loss structures in Lafayette and West Lafayette?
Thanks,
Larry

Larry Aukerman, CFM
Current Planner
Area Plan Commission of Tippecanoe County
20 North 3rd Street
Lafayette IN 47902
Office (765) 423-9242
laukerman@tippecanoe.in.gov

APPENDIX D—POLIS CENTER ANALYSIS

An HAZUS analysis was performed by the Polis Center for this plan. The analysis was completed on Earthquakes, Floods, Tornados, and Hazardous Material Spills.

Tippecanoe County
Vulnerability Analyses Report

The goal of mitigation is to reduce the future impacts of a hazard including loss of life, property damage, disruption to local and regional economies, and the expenditure of public and private funds for recovery. Sound mitigation must be based on sound risk assessment. A risk assessment involves quantifying the potential loss resulting from a disaster by assessing the vulnerability of buildings, infrastructure, and people.

GIS and Hazus-MH Modeling

FEMA's Pre-Disaster Mitigation (PDM) program is designed to provide assistance to local communities to develop and implement their hazard mitigation plan, thereby reducing risk to property and lives.

Existing Hazus-MH technology was used in the development of the vulnerability assessment for flooding and earthquakes. With the implementation of new technology and locally available parcel datasets, more accurate results are now available. Multi-hazard mitigation plan updates may document significant variances from the original MHMP.

The flood and earthquake assessments are based on a Level 2 Hazus analysis. Hazus-MH generated a combination of site-specific (flood) and aggregated loss (earthquake) estimates. Aggregate inventory loss estimates, which include building stock analysis, are based upon the assumption that building stock is evenly distributed across census blocks/tracts. With this in mind, total losses tend to be more reliable over larger geographic areas than for individual census blocks/tracts. Site-specific analysis is based upon loss estimations for individual structures. For flooding, analysis of site-specific structures considers the depth of water in relation to the structure. Hazus-MH also considers the actual dollar exposure to the structure for the costs of building reconstruction, content, and inventory. Damages, however, are based upon the assumption that each structure will fall into a structural class, and structures in each class will respond in a similar fashion to a specific depth of flooding. Site-specific analysis is also based on a point location rather than a polygon; therefore the model does not account for the percentage of a building that is inundated.

It is important to note that Hazus-MH is not intended to be a substitute for detailed engineering studies. Rather, it is intended to serve as a planning aid for communities interested in assessing their risk to flood, earthquake, and hurricane-related hazards. This documentation does not provide full details on the processes and procedures completed in the development of this project. It is only intended to highlight the major steps that were followed during the project.

Assessing Vulnerability

The Indiana Department of Homeland Security, through IndianaMap, provided parcel boundaries to The Polis Center, and the Indiana Department of Local Government and Finance provided the County assessor records. Polis revised the Hazus-MH default data tables to reflect these updates prior to performing the risk assessment in order to improve the accuracy of the model predictions.

The default Hazus-MH data were updated as follows:

- The Hazus-MH defaults, critical facilities, and essential facilities were updated based on the most recent available data sources. Critical and essential point facilities have been reviewed, revised, and approved by local subject matter experts.
- The essential facility updates (schools, medical care facilities, fire stations, police stations, and EOCs) were applied to the Hazus-MH model data. Hazus-MH reports of essential facility losses reflect updated data.

Identify Facilities

This plan includes two types of facilities: critical facilities and essential facilities.

CRITICAL FACILITIES are buildings that are deemed economically or socially viable to the county. Tippecanoe County has the following categories of critical facilities.

- **Transportation Systems** – *14 airports, 6 bus facilities* – necessary for transport of people and resources including airports, highways, railways, and waterways.
- **Lifeline Utility Systems** – 8 *wastewater treatment plants, 32 potable water systems, 59 communications facilities*– vital to public health and safety.
- **Hazardous Material Facilities** – *105 hazardous materials facilities* – involved in the production, storage, and/or transport of corrosives, explosives, flammable materials, radioactive materials, and toxins.

ESSENTIAL FACILITIES are defined as those that are vital to the county in the event of a hazard. These include emergency operations centers, police departments, fire stations, schools, and care facilities. Essential facilities are a subset of critical facilities.

Table 1 identifies the essential facilities that were added or updated for the analysis.

Table 1: Essential Facilities of Tippecanoe County

Category	Number of Facilities
Care Facilities	67
Emergency Operations Centers	1
Fire Stations	23
Police Stations	11
Schools	53
Total	155

Facility Replacement Costs

Facility replacement costs and total building exposure, which reflect local data, are identified in Table 2 along with the estimated number of buildings within each occupancy class.

The Assessor records often do not distinguish parcels by occupancy class when the parcels are not taxable; therefore, the total number of buildings and the building replacement costs for government, religious/non-profit, and education may be underestimated.

Table 2: Building Exposure

General Occupancy	Estimated Total Buildings	Total Building Exposure
Agricultural	1,790	$304,016,238
Commercial	1,920	$1,537,354,309
Education	7	$5,696,210
Government	83	$89,675,080
Industrial	120	$628,132,545
Religious/Non-Profit	337	$410,050,341
Residential	45,119	$7,706,238,564
Total	**49,376**	**$10,681,163,287**

Profiling Hazards

Tornadoes

Tornadoes can occur at any time during the day or night. The unpredictability of tornadoes makes them one of Indiana's most dangerous hazards. Their extreme winds are violently destructive when they touch down in the region's developed and populated areas. Current estimates place the maximum velocity at about 300 miles per hour, but higher and lower values can occur. A wind velocity of 200 miles an hour will result in a wind pressure of 102.4 pounds per square foot of surface area—a load that exceeds the tolerance limits of most buildings.

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 violently-rotating column of air can reach the ground very quickly and become a tornado. If the funnel cloud picks up and blows debris, it has reached the ground and is a tornado.

Tornadoes are classified according to the Fujita tornado intensity scale[1] as shown in Table 3.

Table 3: Enhanced Fujita Tornado Rating

Fujita Number	Estimated Wind Speed	Path Width	Path Length	Description of Destruction
EF0 *Gale*	65-85 mph	6-17 yards	0.3-0.9 miles	Light damage, some damage to chimneys, branches broken, sign boards damaged, shallow-rooted trees blown over.
FE1 *Moderate*	86-110 mph	18-55 yards	1.0-3.1 miles	Moderate damage, roof surfaces peeled off, mobile homes pushed off foundations, attached garages damaged.
EF2 *Significant*	111-135 mph	56-175 yards	3.2-9.9 miles	Considerable damage, entire roofs torn from frame houses, mobile homes demolished, boxcars pushed over, large trees snapped or uprooted.
EF3 *Severe*	136-165 mph	176-566 yards	10-31 miles	Severe damage, walls torn from well-constructed houses, trains overturned, most trees in forests uprooted, heavy cars thrown about.
EF4 *Devastating*	166-200 mph	0.3-0.9 miles	32-99 miles	Complete damage, well-constructed houses leveled, structures with weak foundations blown off for some distance, large missiles generated.
EF5 *Incredible*	Over 200 mph	1.0-3.1 miles	100-315 miles	Foundations swept clean, automobiles become missiles and thrown for 100 yards or more, steel-reinforced concrete structures badly damaged.

[1] NOAA Storm Prediction Center, http://www.srh.noaa.gov

Vulnerability Analysis for Tornadoes

Tornadoes can occur within any area in the county; therefore the entire county population and all buildings are vulnerable to tornadoes. To accommodate this risk, this plan will consider all buildings within the county as vulnerable.

Essential Facilities

All essential facilities are vulnerable to tornadoes. An essential facility will encounter many of the same impacts as any other building within the jurisdiction. These impacts will vary, based on the magnitude of the tornado, but can include structural failure, damaging debris (trees or limbs), roofs blown off or windows broken by hail or high winds, and loss of facility functionality (e.g., a damaged police station will no longer be able to serve the community).

Building Inventory

The same impacts to buildings within the county can be expected. The impacts are similar to those discussed for critical facilities and include structural failure, damaging debris (trees or limbs), roofs blown off or windows broken by hail or high winds, and loss of building function (e.g., damaged home will no longer be habitable causing residents to seek shelter).

Infrastructure

During a tornado, the types of infrastructure that could be impacted include roadways, utility lines/pipes, railroads, and bridges. Because the county's entire infrastructure is equally vulnerable, it is important to emphasize that any number of these structures could become damaged during a tornado. The impacts to these structures include broken, failed, or impassable roadways, broken or failed utility lines (e.g., loss of power or gas to community), and railway failure from broken or impassable railways. Bridges could fail or become impassable, causing risk to traffic.

GIS Tornado Analysis

GIS overlay modeling was used to determine the potential impacts of an F4 tornado. The analysis used a hypothetical tornado path that runs for 8.4 miles through Lafayette communities. The selected widths were modeled after a recreation of the Fujita-Scale guidelines based on conceptual wind speeds, path widths, and path lengths. There is no guarantee that every tornado will fit exactly into one of these six categories. Table 4 depicts tornado damage curves as well as path widths.

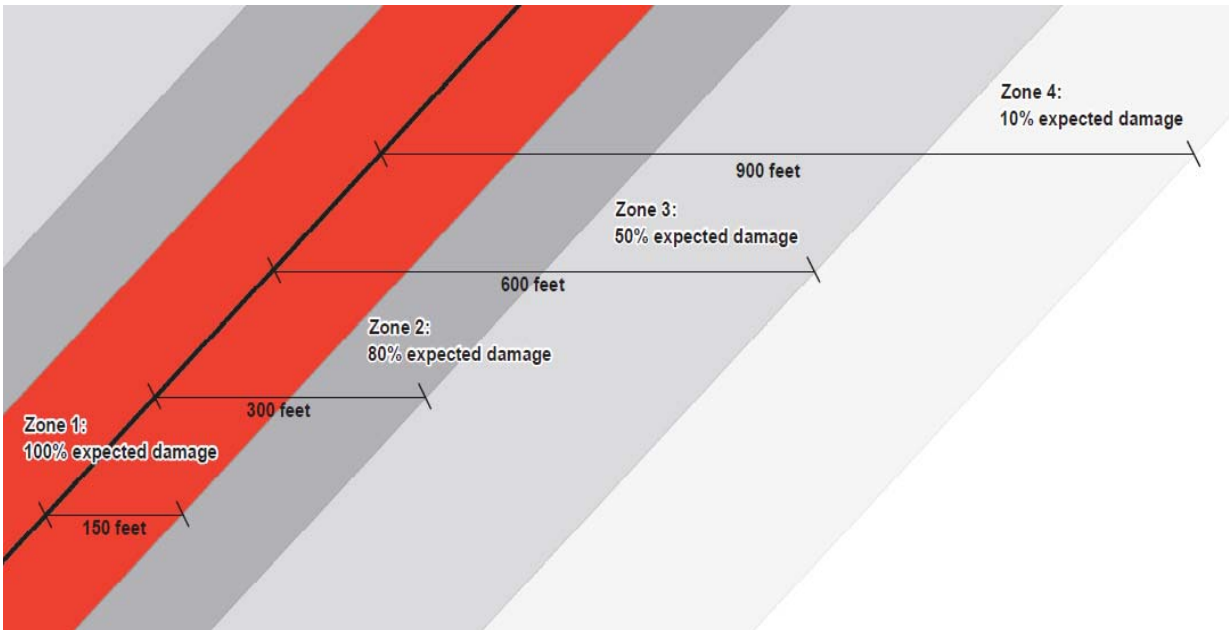
Table 4: Tornado Path Widths and Damage Curves

Fujita Scale	Path Width (feet)	Maximum Expected Damage
F-5	3000	100%
F-4	2400	100%
F-3	1800	80%
F-2	1200	50%
F-1	600	10%
F-0	300	0%

Within any given tornado path there are degrees of damage. The most intense damage occurs within the center of the damage path with a decreasing amount of damage away from the center of the path. This natural process was modeled in GIS by adding damage zones around the tornado path.

Figure 1 and Table 5 describe the zone analysis.

Figure 1: GIS Analysis Using Tornado Buffers



Once the hypothetical route is digitized on a map, several buffers are created to model the damage functions within each zone.

An F4 tornado has four damage zones. Total devastation is likely to occur within 150 feet of the tornado path (the darker-colored Zone 1). The outer buffer is 900 feet from the tornado path (the lightest colored Zone 4), within which buildings will be damaged by approximately 10%.

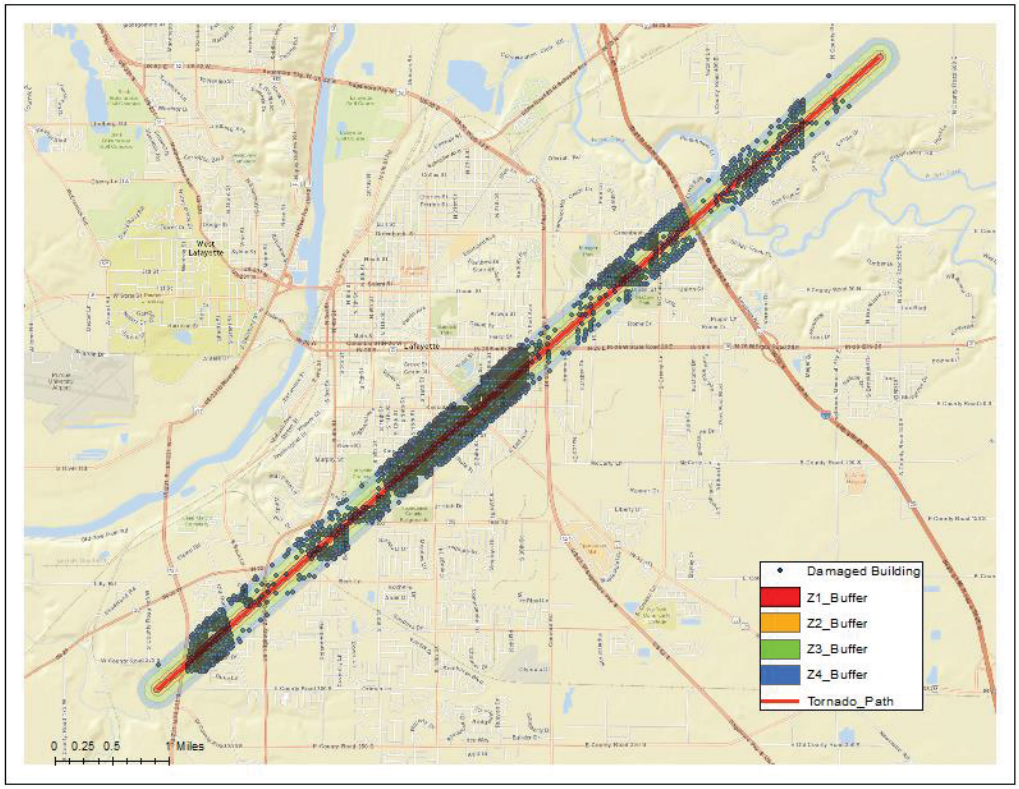
Table 5: Tornado Zones and Damage Curves

Fujita Scale	Zone	Buffer (feet)	*Damage Curve*
F-4	4	600-900	10%
F-4	3	300-600	50%
F-4	2	150-300	80%
F-4	1	0-150	100%

The hypothetical tornado path is depicted in Figure 16 and the damage curve buffers are in Figures 2 and 3.

Figure 2: Hypothetical F4 Tornado Path in Tippecanoe County

Figure 3: Modeled F4 Tornado Damage Buffers in Tippecanoe County



The GIS analysis estimates that 2,898 buildings will be damaged. The estimated building losses were $233 million. The building losses are an estimate of building replacement costs multiplied by the percentages of damage. The overlay was performed against parcels that were joined with Assessor records showing property replacement value.

The Assessor records often do not distinguish parcels by occupancy class if the parcels are not taxable. For purposes of analysis, the total number of buildings and the building replacement costs for government, religious/non-profit, and education may be underestimated.

The results of the analysis are depicted in Tables 6 and 7.

Table 6: Estimated Numbers of Buildings Damaged by Occupancy Type

Occupancy	Damaged Buildings
Commercial	120
Industrial	1
Religious	12
Residential	2,765
Total	2,898

Table 7: Estimated Building Losses by Occupancy Type

Occupancy	Building Losses
Commercial	$36,970,932
Industrial	$305,305
Religious	$6,531,609
Residential	$189,176,341
Total	$232,984,187

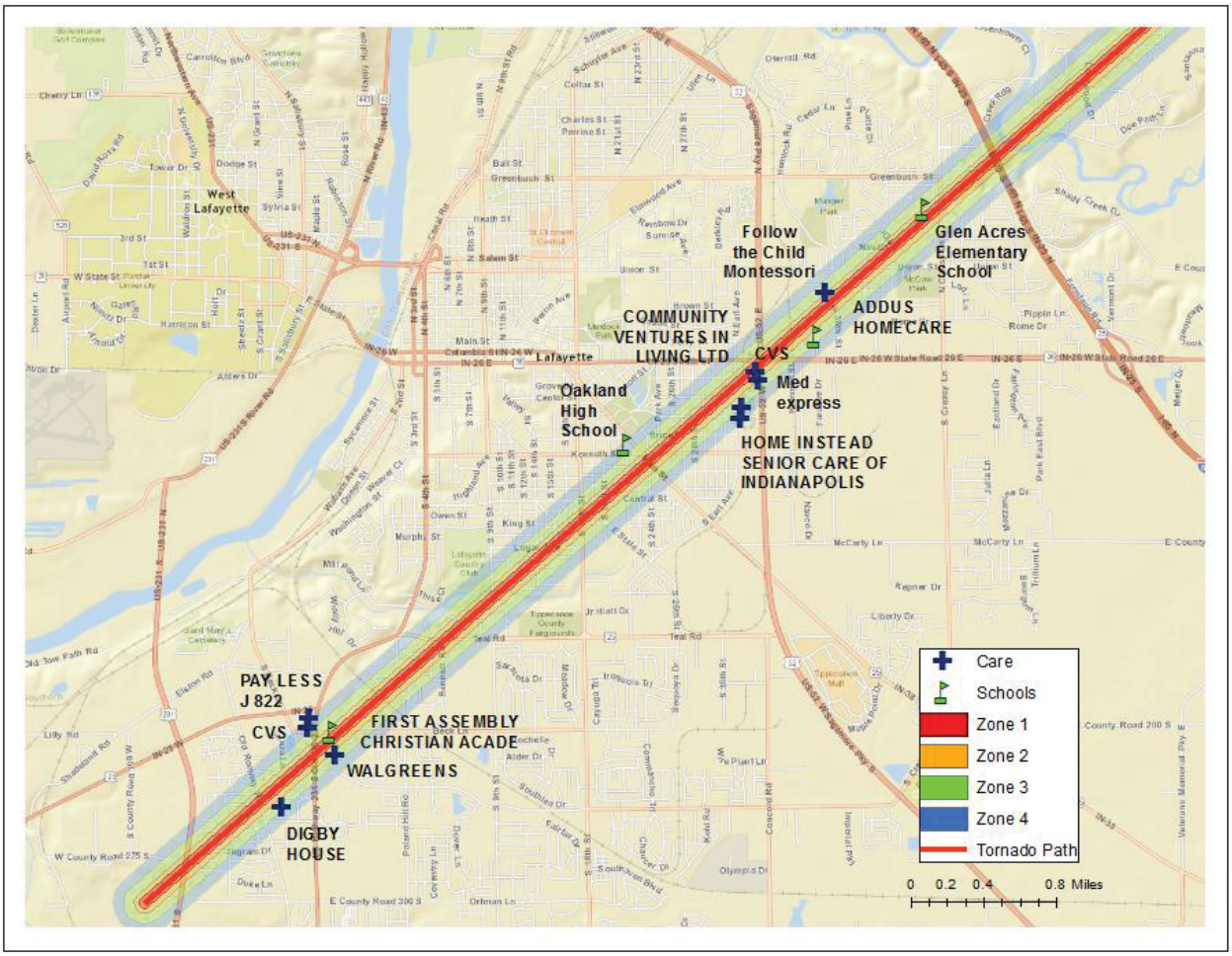
Essential Facilities Damage

There are eleven essential facilities located within 600 feet of the hypothetical tornado path. The model predicts that nine Care facilities and four Schools would experience damage. The affected facilities are identified in in Table 8, and their geographic locations are shown in Figure 4.

Table 8: Estimated Essential Facilities Affected

Name
CVS
WALGREENS
HOME INSTEAD SENIOR CARE OF INDIANAPOLIS
ADDUS HOMECARE
COMMUNITY VENTURES IN LIVING LTD
PAY LESS J 822
DIGBY HOUSE
Med express
Oakland High School
Glen Acres Elementary School
Follow the Child Montessori
FIRST ASSEMBLY CHRISTIAN ACADEMY

Figure 4: Modeled F4 Tornado Damage Buffers in Tippecanoe County



Flood Hazard

Flooding is a significant natural hazard throughout the United States. The type, magnitude, and severity of flooding are functions of the amount and distribution of precipitation over a given area, the rate at which precipitation infiltrates the ground, the geometry of the catchment, and flow dynamics and conditions in and along the river channel. Floods can be classified as one of two types: Flash floods or riverine floods. Both types of floods are common in Indiana.

Riverine floods refer to floods on large rivers at locations with large upstream catchments. Riverine floods are typically associated with precipitation events that are of relatively long duration and occur over large areas. Flooding on small tributary streams may be limited, but the contribution of increased runoff may result in a large flood downstream. The lag time between precipitation and time of the flood peak is much longer for riverine floods than for flash floods, generally providing ample warning for people to move to safe locations and, to some extent, secure some property against damage. Riverine flooding on the large rivers of Indiana generally occurs during either the spring or summer.

Vulnerability Analysis

Hazus-MH estimates the 1%-annual-chance flood (AKA 100-year flood) would damage 911 buildings at a replacement cost of $104,631,000. Lafayette community sustained the most damage with 114 buildings damaged at a replacement cost of $11,581,000. West Lafayette sustained considerably higher damage compared to Lafayette with 5 buildings at a replacement cost of $12,812,000. The total estimated numbers and cost of damaged buildings by community are given in Tables 9 and 10. Figure 5 depicts the Tippecanoe County parcel points that fall within the 1%-annual-chance flood risk area (AKA 100-year floodplain). Figures 6 through 11 highlight damaged buildings within the floodplain areas in each flood-prone jurisdiction.

Table 9: Number of Buildings Damaged by Community and Occupancy

Community	Total Buildings Damaged	Building Occupancy Class						
		Agriculture	Commercial	Education	Government	Industrial	Religious	Residential
Battle Ground	6	0	0	0	0	0	0	6
Clarks Hill	0	0	0	0	0	0	0	0
Dayton	0	0	0	0	0	0	0	0
Lafayette	114	0	16	0	2	0	3	93
Otterbein	0	0	0	0	0	0	0	0
Shadeland	13	6	0	0	0	0	0	7
West Lafayette	5	0	0	0	0	0	0	5
Unincorporated	773	126	9	0	3	3	4	628
Total	**911**	**132**	**25**	**0**	**5**	**3**	**7**	**739**

Table 10: Cost of Buildings Damaged by Community and Occupancy

Community	Total Losses ($)	Building Occupancy Class						
		Agriculture	Commercial	Education	Government	Industrial	Religious	Residential
Battle Ground	355,265	0	0	0	0	0	0	355,265
Clarks Hill	0	0	0	0	0	0	0	0
Dayton	0	0	0	0	0	0	0	0
Lafayette	11,580,877	0	3,748,302	0	317,125	0	1,475,561	6,039,889
Otterbein	0	0	0	0	0	0	0	0
Shadeland	1,221,651	725,443	0	0	0	0	0	496,208
West Lafayette	12,811,800	0	0	0	0	0	0	12,811,800
Unincorporated	78,661,362	10,210,321	2,376,900	0	12,556	453,084	4,981,034	60,627,467
Total	**104,630,955**	**10,935,764**	**6,125,202**	**0**	**329,681**	**453,084**	**6,456,595**	**80,330,629**

Figure 5: Tippecanoe County Buildings in Floodplain (1% Annual Chance)

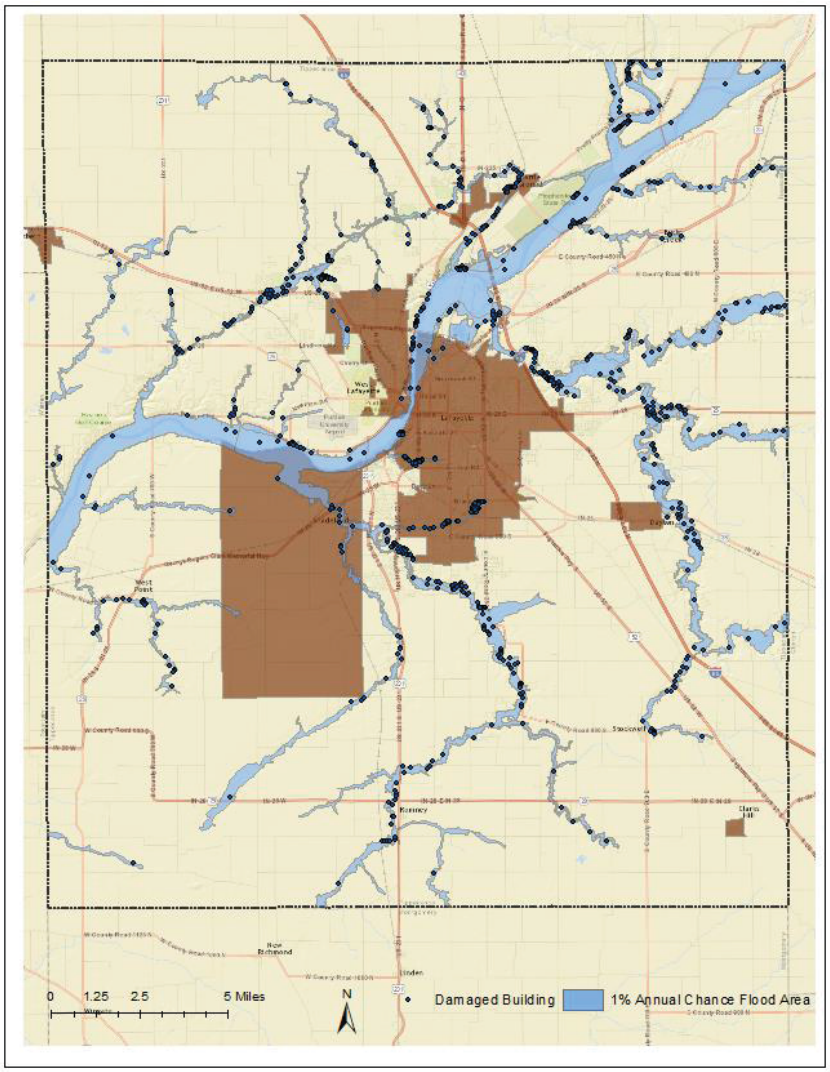


Figure 6: Tippecanoe County Unincorporated Flood Prone Areas (1% Annual Chance)

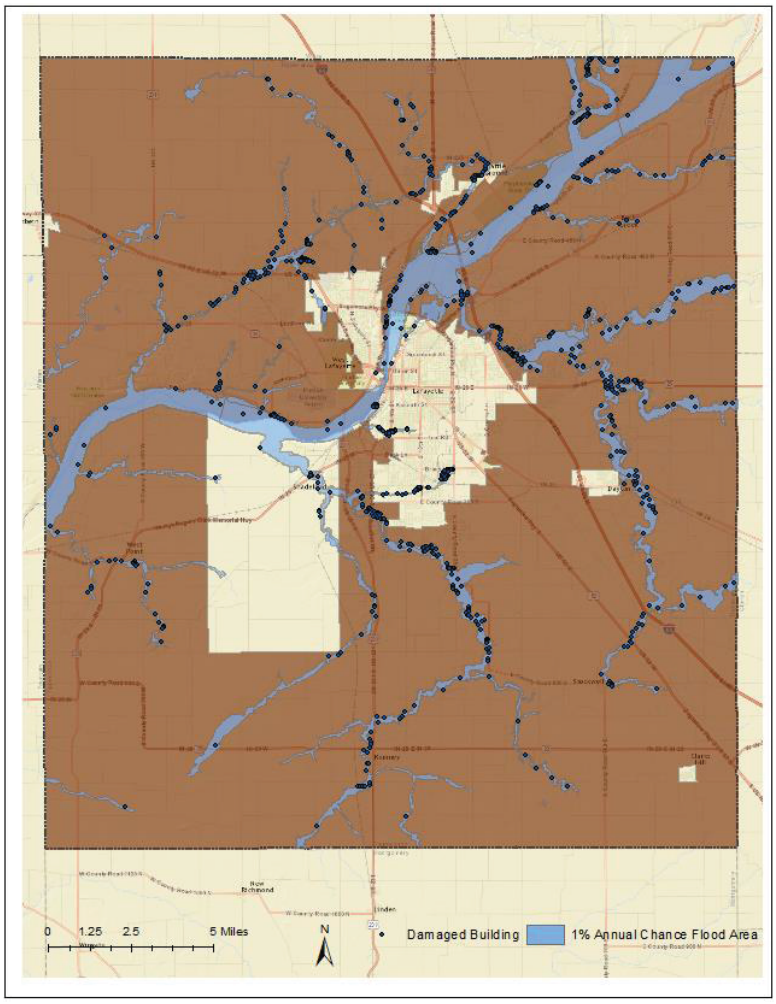


Figure 3: Tippecanoe County Battle Ground Flood-Prone Areas (1% Annual Chance)

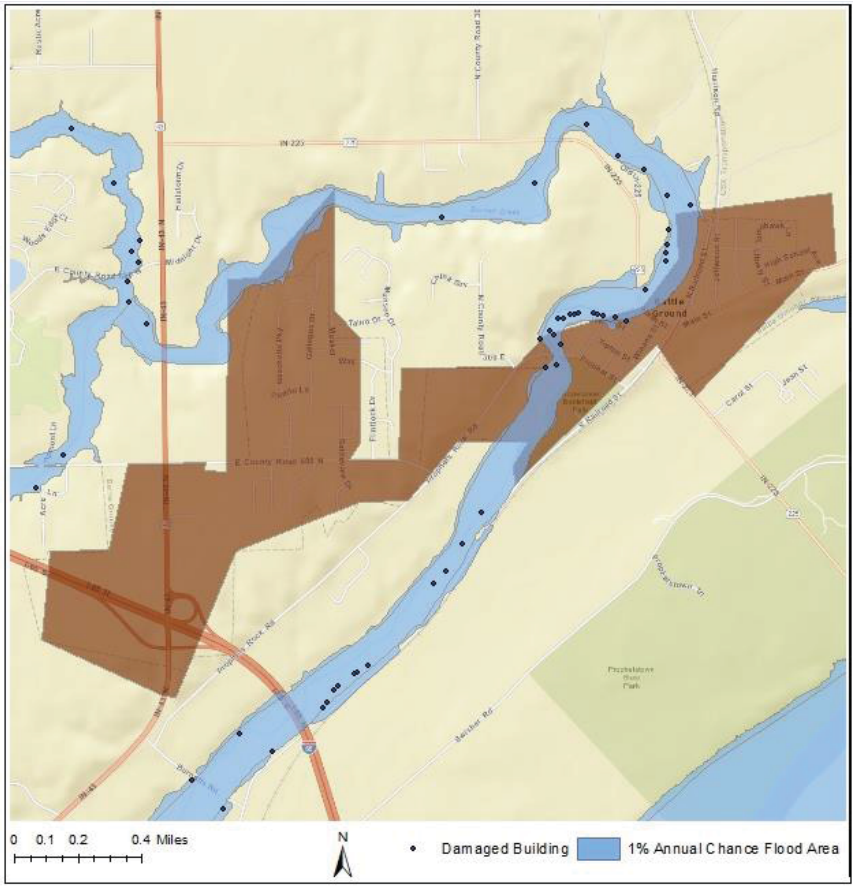


Figure 84: Tippecanoe County Lafayette Flood-Prone Areas (1% Annual Chance)

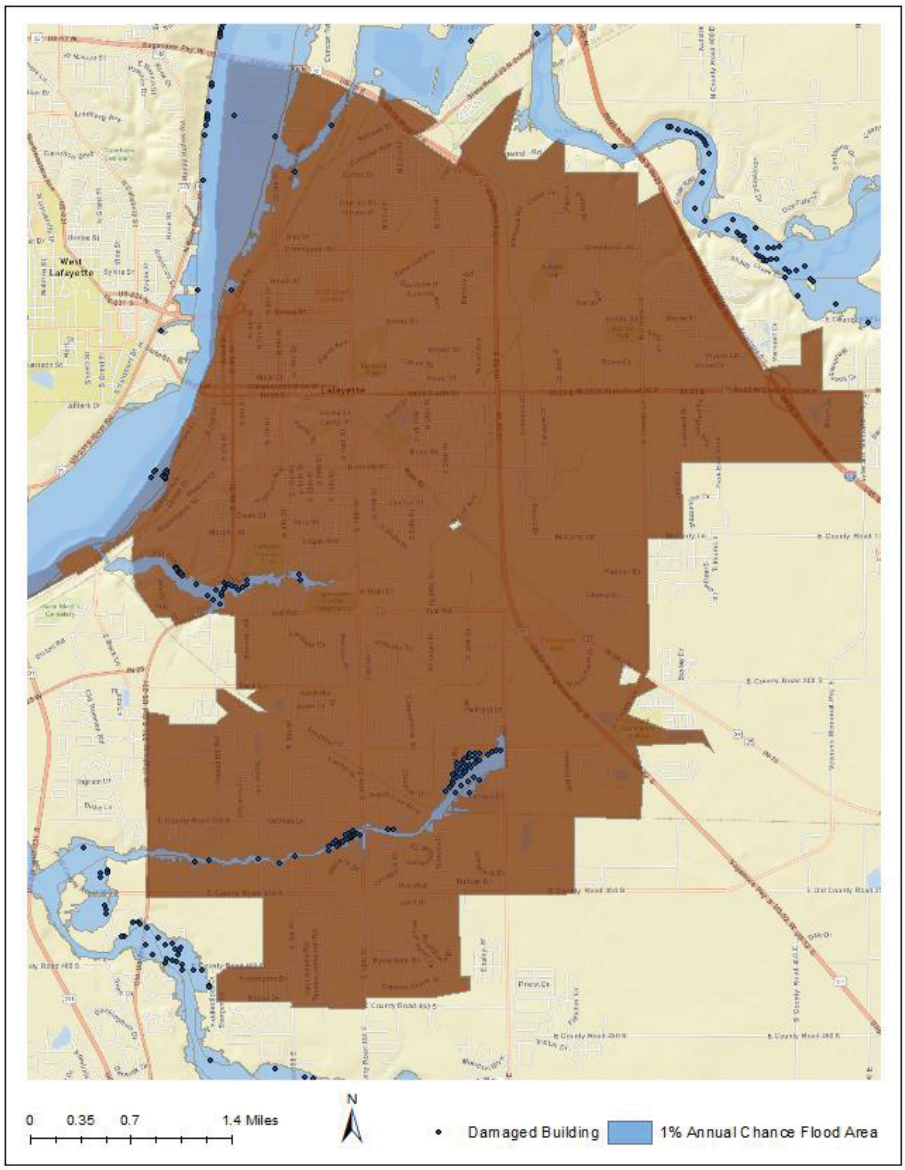


Figure 9: Tippecanoe County West Lafayette Flood-Prone Areas (1% Annual Chance)

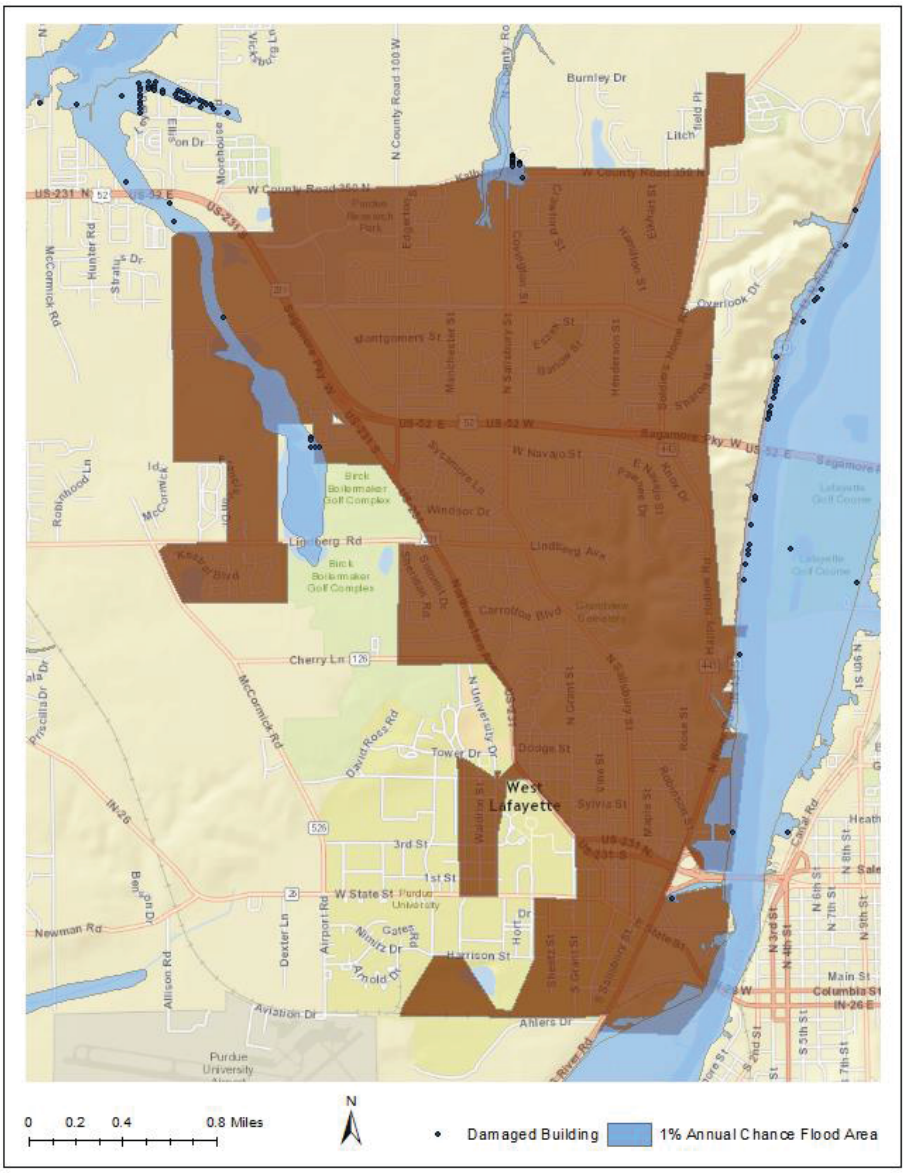


Figure 10: Tippecanoe County Shadeland Flood-Prone Areas (1% Annual Chance)

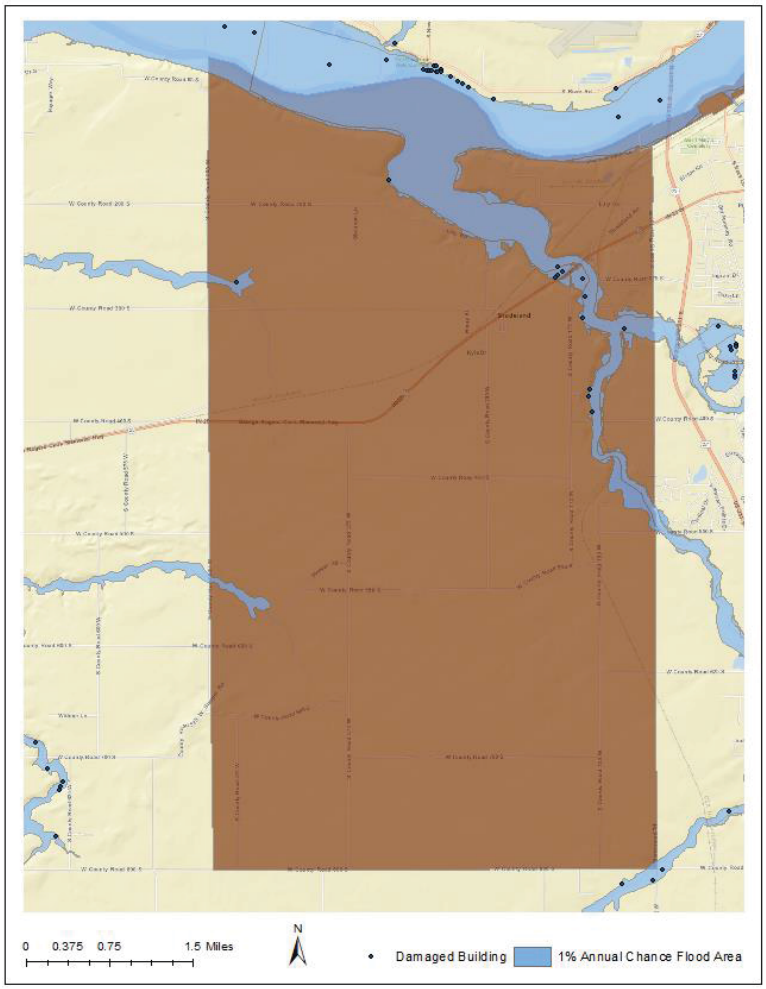
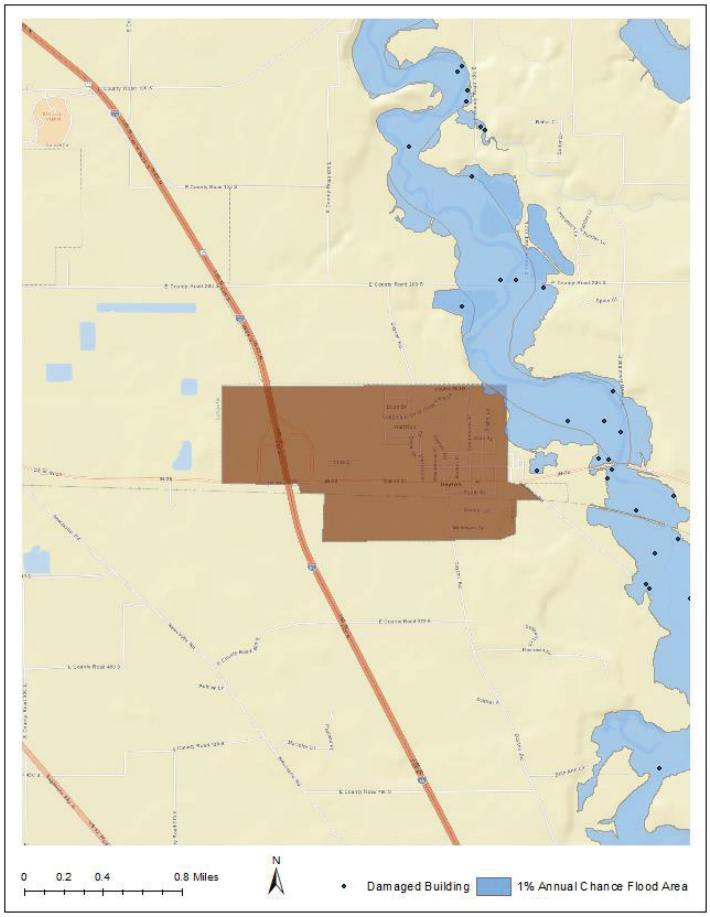


Figure 11: Tippecanoe County Dayton Flood-Prone Areas (1% Annual Chance)

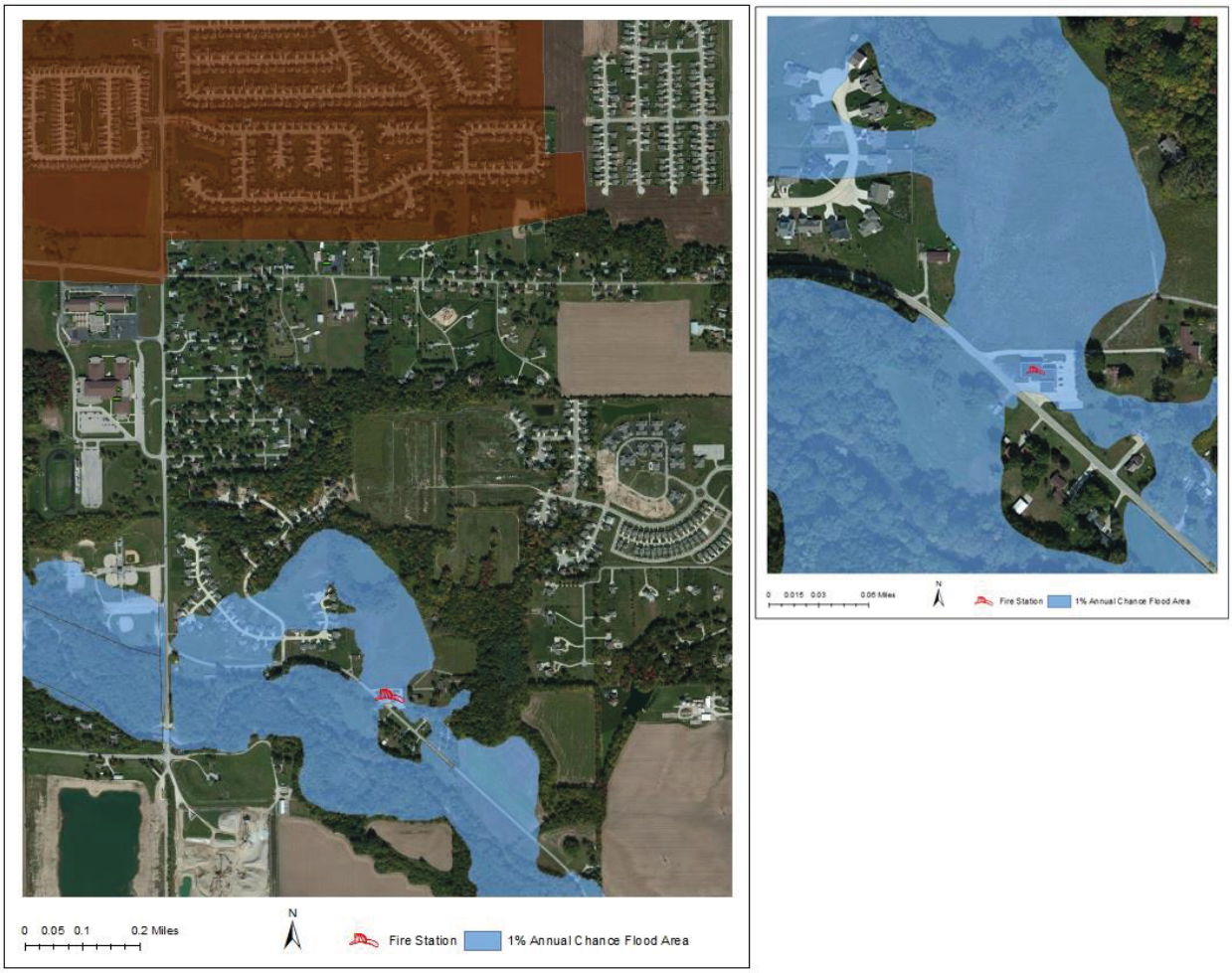


Hazus-MH Overlay Analysis of Essential Facilities

An essential facility will encounter many of the same impacts as other buildings within the flood boundary. These impacts can include structural failure, extensive water damage to the facility and loss of facility functionality (e.g. a damaged fire station will no longer be able to serve the community).

The results of the overlay analysis indicate that thirteen essential facilities in Tippecanoe County could sustain damage. One Fire Station, in the unincorporated community is within the 1% flood probability area.

Figure 12: Boundary of 1% Annual Chance Flood Overlaid with Unincorporated Tippecanoe Essential Facilities



Hazus-MH Overlay Analysis of Critical Facilities

A critical facility will encounter many of the same impacts as other buildings within the flood boundary. These impacts can include structural failure, extensive water damage to the facility and loss of facility functionality (e.g. a damaged waste water facility will no longer be able to serve the community).

The results of the overlay analysis, shown in Figures 13 through, indicate that 16 critical facilities in Tippecanoe County could sustain damage: fourteen potable water facilities and two wastewater facilities.

Figure 13: Boundary of 1% Annual Chance Flood Overlaid with Lafayette Critical Facilities

Figure 14: Boundary of 1% Annual Chance Flood Overlaid with Battleground Critical Facilities

Figure 15: Boundary of 1% Annual Chance Flood Overlaid with Unincorporated Critical Facilities

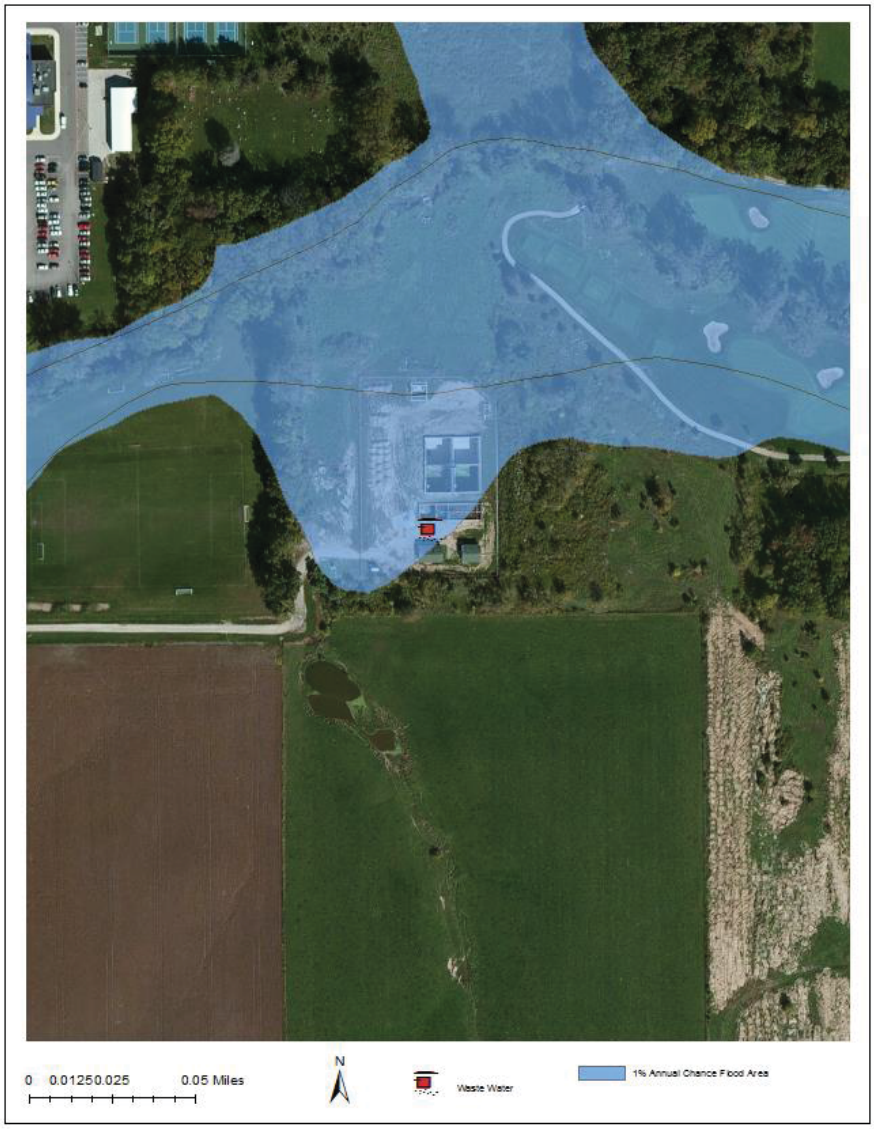


Figure 16: Boundary of 1% Annual Chance Flood Overlaid within Tippecanoe County Unincorporated area Critical Facilities

Buyouts

Tippecanoe County has a total of 11 buyouts, and two of those are within Lafayette. Figures 17 and 18 map the buyouts in Tippecanoe County, and Lafayette community, respectively.

Figure 17: Buyouts in Tippecanoe County

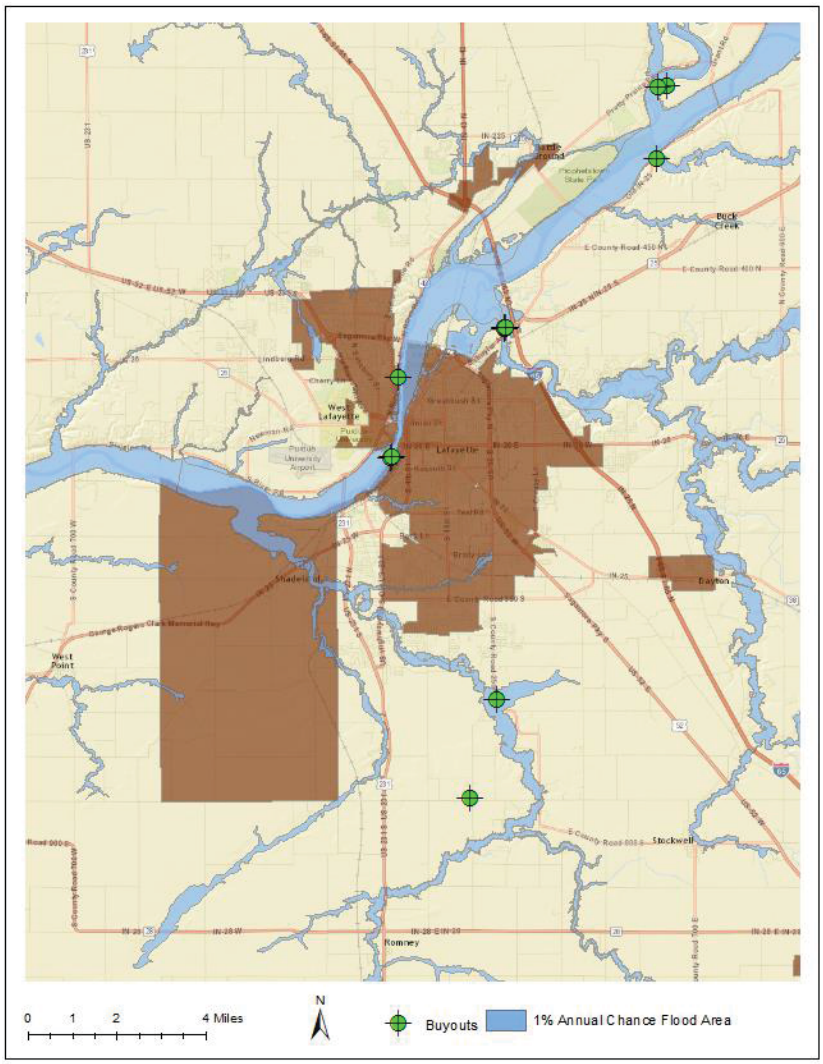


Figure 18: Buyouts in Lafayette Community

Earthquake Hazard

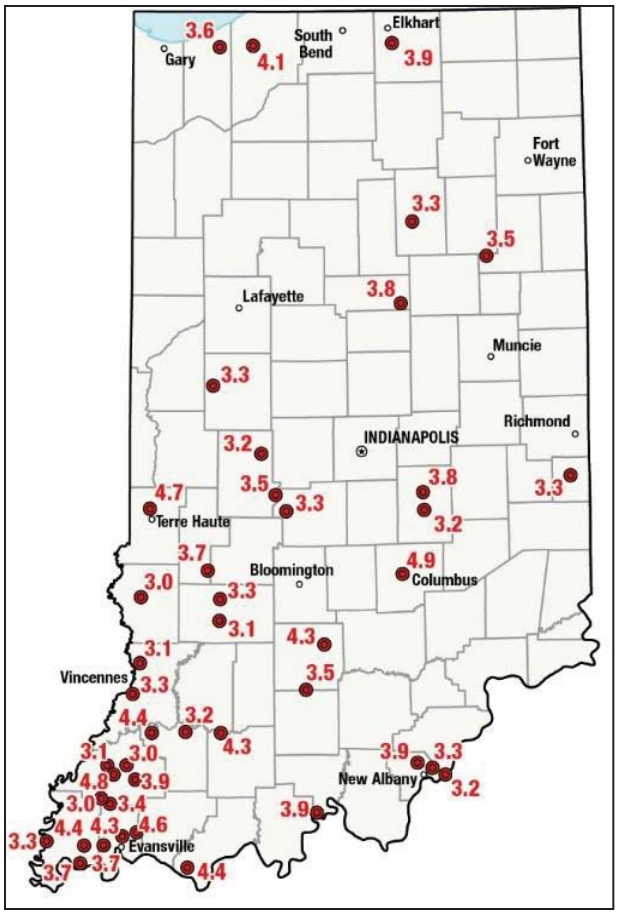
Hazard Definition for Earthquake Hazard

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 Earth as the huge plates that form the Earth's crust collide, move away from, and slide past each other. This movement is extremely slow. However, when sections of the plates are locked together, stored energy is accumulated. When the accumulated energy grows strong enough, the portions of the plate break free, causing the earthquake.

Ninety-five percent of earthquakes occur at the plate boundaries; however, some earthquakes occur in the middle of plates, as is the case for seismic zones in the Midwestern United States. The most seismically active area in the Central United States is referred to as the New Madrid Seismic Zone. Scientists have learned that the New Madrid fault system may not be the only fault system in the central US capable of producing damaging earthquakes. The Wabash Valley Fault System in Indiana shows evidence of large earthquakes in its geologic history, and there may be other currently unidentified faults that could produce strong earthquakes. Figure 19 depicts Indiana's historical earthquake epicenters.

Ground shaking from strong earthquakes can collapse buildings and bridges; disrupt gas, electric, and communication (e.g. phone, cable, Internet) services; and sometimes trigger landslides, flash floods, and fires. Buildings with foundations resting on unconsolidated landfill and other unstable soil, and trailers or homes not tied to their foundations are at risk because they can be shaken off their mountings during an earthquake. When an earthquake occurs in a populated area, it may cause deaths, injuries, and extensive property damage.

Figure 19: Indiana Historical Earthquake Epicenters[2]



[2] Indiana Geological Survey

The Modified Mercalli Intensity Scale is an arbitrary ranking based on observed effects that used in the United States to evaluate the intensity of earthquakes. Table 11 describes the 12 increasing levels of the scale. Table 12 shows how the Modified Mercalli Intensity Scale compares to earthquake magnitude.

Table 11: Modified Mercalli Intensity Scale

Modified Mercalli Intensity	Description
I	Not felt except by a very few under especially favorable conditions.
II	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Table 12: Earthquake Magnitude vs. Modified Mercalli Intensity Scale

Earthquake Magnitude	Typical Maximum Modified Mercalli Intensity
1.0 - 3.0	I
3.0 - 3.9	II - III
4.0 - 4.9	IV - V
5.0 - 5.9	VI - VII
6.0 - 6.9	VII - IX
7.0 and higher	VIII or higher

Hazus-MH Earthquake Analysis

The Polis Center reviewed existing geological information and recommendations for earthquake scenarios and ran four modeling scenarios—two deterministic, one probabilistic, and an annualized loss.

The deterministic scenarios included a 7.7-magnitude epicenter along the New Madrid fault zone and a 6.8-magnitude epicenter in Mount Carmel, Illinois.

Modeling a deterministic scenario requires user input for a variety of parameters. One of the most critical sources of information required for accurate assessment of earthquake risk is soils data. Fortunately, a National Earthquake Hazards Reduction Program (NEHRP) soil classification map exists for Indiana. NEHRP soil classifications portray the degree of shear-wave amplification that can occur during ground shaking. The Indiana State Geological Survey supplied the soils map used for the analysis. FEMA provided a map for liquefaction potential that was used by Hazus-MH.

An earthquake depth of 10.0 kilometers was selected based on input from the Indiana Geological Survey. Hazus-MH also requires the user to define an attenuation function unless ground motion maps are supplied. Because Indiana has experienced smaller earthquakes, the decision was made to use the Central Eastern United States (CEUS) attenuation function.

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The probabilistic scenario was based on ground-shaking parameters derived from US Geological Survey probabilistic seismic hazard curves. The probabilistic scenario was a 500-year return period scenario.

This analysis evaluates the average impacts of a multitude of possible earthquake epicenters with a magnitude that would be typical of that expected for a 500-year return period. These analysis options were chosen because they are useful for prioritization of seismic reduction measures and for simulating mitigation strategies.

Results for 7.7 Magnitude- New Madrid, Kentucky Earthquake Scenario

Hazus estimates that the damages incurred from the 7.7 magnitude New Madrid earthquake scenario would be county-wide in scope.

Building Damages

Hazus estimates that 35 buildings in Tippecanoe County would be at least moderately damaged. This is over 0% of the buildings in the county. The model estimates that no buildings would be damaged beyond repair. Table 13 lists the numbers and occupancy types of buildings that would be damaged.

Table 14 on the following page lists the direct economic losses due to building damage, which consist of income loss and capital stock loss. Figure 20 maps the building losses in thousands of dollars.

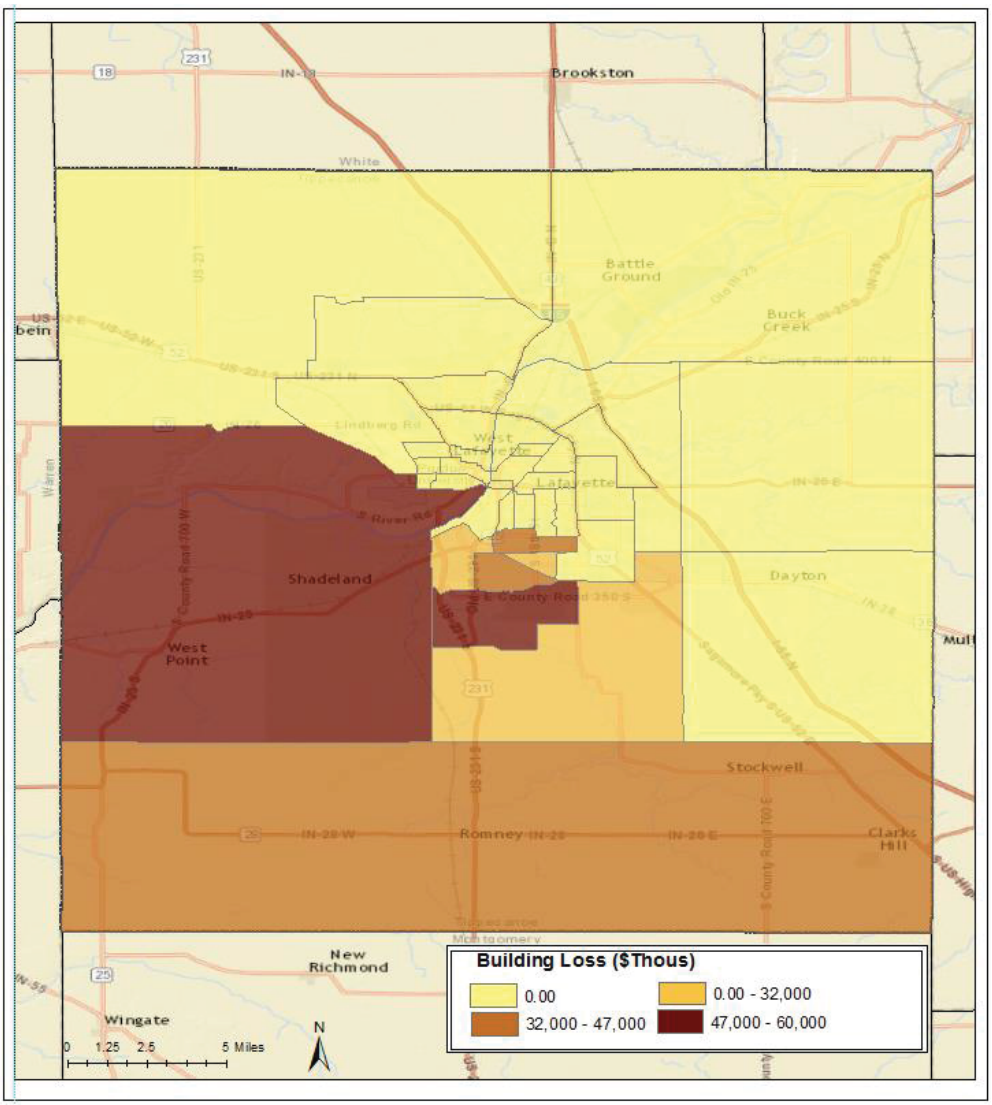
Table13: New Madrid Scenario - Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	314	0.63	2	1.72	1	2.43	0	3.20	0	1.96
Commercial	2,634	5.27	7	4.90	2	6.16	0	7.87	0	5.17
Education	113	0.23	0	0.20	0	0.26	0	0.33	0	0.35
Government	65	0.13	0	0.11	0	0.13	0	0.16	0	0.19
Industrial	677	1.35	2	1.63	1	2.09	0	2.64	0	1.50
Other Residential	10,035	20.09	23	16.37	6	17.82	0	10.76	0	9.07
Religion	279	0.56	1	0.63	0	0.83	0	1.08	0	0.85
Single Family	35,846	71.75	107	74.44	23	70.28	2	73.97	0	80.91
Total	**49,962**		**143**		**33**		**3**		**0**	

Table 2: New Madrid Scenario - Building Losses in Millions of Dollars

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.00	0.03	0.00	0.01	0.04
	Capital-Related	0.00	0.00	0.03	0.00	0.00	0.04
	Rental	0.03	0.01	0.03	0.00	0.00	0.07
	Relocation	0.11	0.01	0.03	0.01	0.02	0.18
	Subtotal	**0.14**	**0.03**	**0.13**	**0.01**	**0.03**	**0.34**
Capital Stock Losses							
	Structural	0.21	0.02	0.04	0.01	0.03	0.32
	Non_Structural	0.32	0.04	0.04	0.01	0.02	0.44
	Content	0.02	0.00	0.01	0.00	0.00	0.04
	Inventory	0.00	0.00	0.00	0.00	0.00	0.00
	Subtotal	**0.56**	**0.07**	**0.08**	**0.03**	**0.05**	**0.79**
	Total	**0.70**	**0.10**	**0.21**	**0.04**	**0.08**	**1.13**

Figure 50: New Madrid Scenario - Building Losses in Thousands of Dollars



Essential Facility Damage

Before the earthquake, the county had an estimated 3,006 medical care facility beds available for use. On the day of the earthquake, the model estimates that 2,923 beds (97%) would be available for use by patients already in these facilities along with those injured by the earthquake. After one week, 99% of the beds would likely be back in service. By 30 days, 100% would likely be operational.

Table 15: New Madrid Scenario - Essential Facility Damage

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	67	0	0	67
Schools	56	0	0	56
EOCs	1	0	0	1
PoliceStations	11	0	0	11
FireStations	23	0	0	23

Results for 6.8 Magnitude- Mt. Carmel, Illinois Earthquake Scenario

The extent of the damages from a 6.8 Magnitude at Mt. Carmel, Illinois epicenter would encompass all areas of Tippecanoe County.

Building Damages

Hazus estimates that about 956 buildings in Tippecanoe County would be at least moderately damaged. This is over 2% of the buildings in the county. An estimated nine buildings would be damaged beyond repair. Table 16 on the following page lists the numbers and occupancy types of buildings that would be damaged, Table 17 lists the direct economic losses due to building damage, which consist of income loss and capital stock loss, and Figure 21 maps the building losses in thousands of dollars.

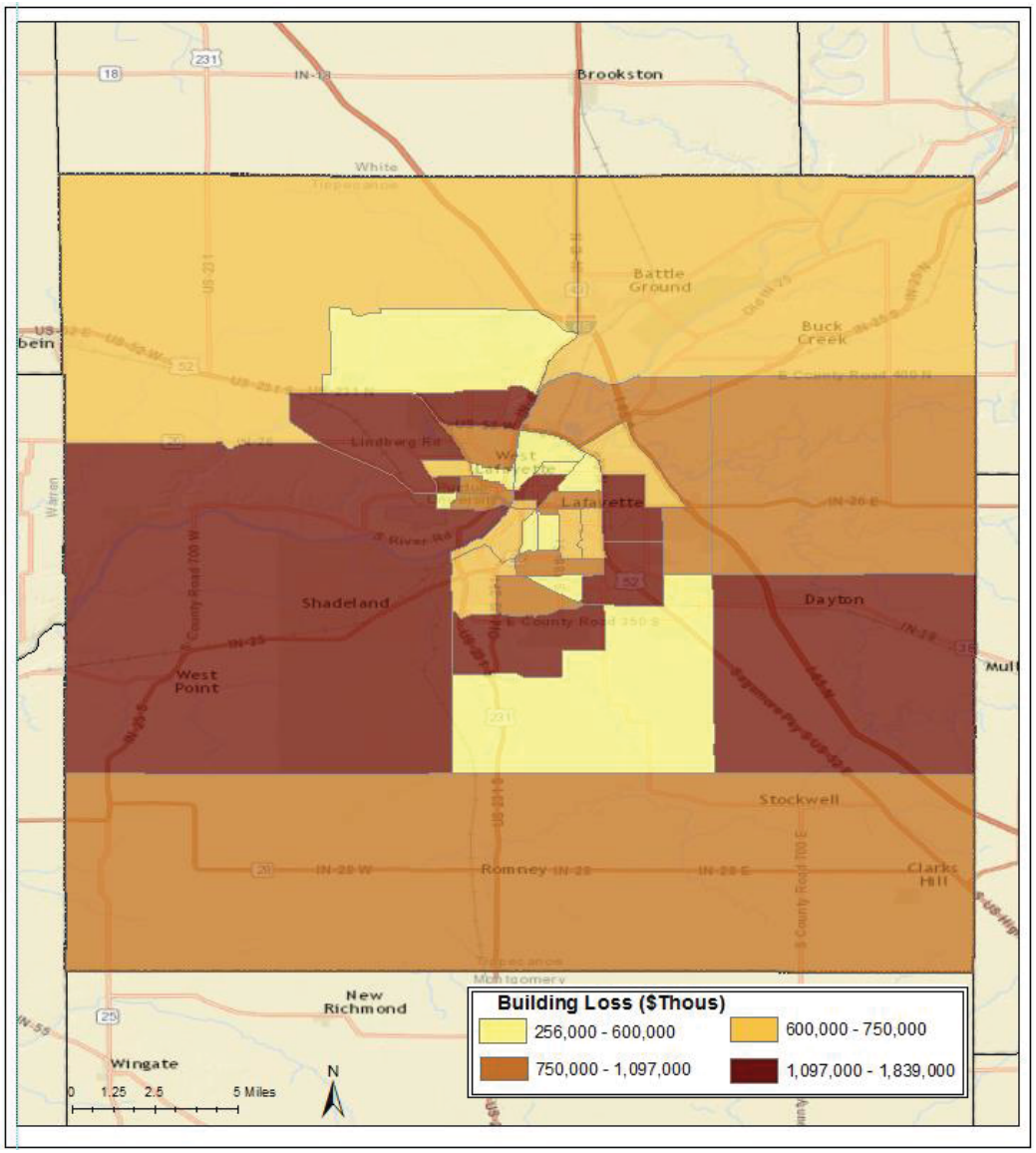
Table16: Mt. Carmel Scenario - Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	284	0.61	22	0.75	10	1.19	2	1.64	0	1.04
Commercial	2,396	5.17	168	5.88	67	7.94	11	10.43	1	7.79
Education	102	0.22	7	0.25	3	0.36	0	0.44	0	0.52
Government	60	0.13	4	0.13	1	0.18	0	0.20	0	0.24
Industrial	615	1.33	43	1.51	18	2.16	3	2.83	0	1.78
Other Residential	9,147	19.75	664	23.19	231	27.43	21	20.02	2	18.08
Religion	253	0.55	19	0.65	8	0.90	1	1.21	0	1.14
Single Family	33,464	72.24	1,937	67.64	505	59.85	66	63.23	7	69.41
Total	**46,321**		**2,863**		**843**		**104**		**9**	

Table17: Mt. Carmel Scenario - Building Losses in Millions of Dollars

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.23	2.60	0.12	0.25	3.19
	Capital-Related	0.00	0.10	2.13	0.07	0.07	2.37
	Rental	0.71	1.38	1.61	0.05	0.09	3.85
	Relocation	2.61	0.95	2.52	0.23	0.82	7.13
	Subtotal	**3.32**	**2.67**	**8.85**	**0.47**	**1.22**	**16.54**
Capital Stock Losses							
	Structural	4.59	2.48	2.57	0.50	0.73	10.87
	Non_Structural	9.07	5.64	3.65	0.68	1.15	20.19
	Content	1.21	0.74	1.31	0.39	0.40	4.04
	Inventory	0.00	0.00	0.05	0.09	0.01	0.15
	Subtotal	**14.87**	**8.85**	**7.57**	**1.67**	**2.28**	**35.24**
	Total	**18.19**	**11.52**	**16.42**	**2.14**	**3.50**	**51.78**

Figure21: Mt. Carmel Illinois Scenario - Building Losses in Thousands of Dollars



Essential Facility Damage

Before the earthquake, the county would have an estimated 3,006 medical care facility beds available for use. On the day of the earthquake, the model estimates that 2,600 beds (87%) would be available for use by patients already in these facilities along with those injured by the earthquake. After one week, 93% of the beds would likely be back in service. By 30 days, 99% would likely be operational.

Table 3: Mt. Carmel Scenario - Essential Facility Damage

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	67	0	0	67
Schools	56	0	0	56
EOCs	1	0	0	1
PoliceStations	11	0	0	11
FireStations	23	0	0	23

Results for Probabilistic 500-Year Earthquake Scenario

The results of the initial analysis, the probabilistic 500-year are depicted in Tables 19 and 20 and Figure 22. Hazus-MH estimates that approximately 733 buildings will be at least moderately damaged. This is over 1% of the total number of buildings in the region. The model estimates that no buildings will be damaged beyond repair.

The aggregate building related losses totaled $40.74 million; 31% of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up more than 57% of the total loss.

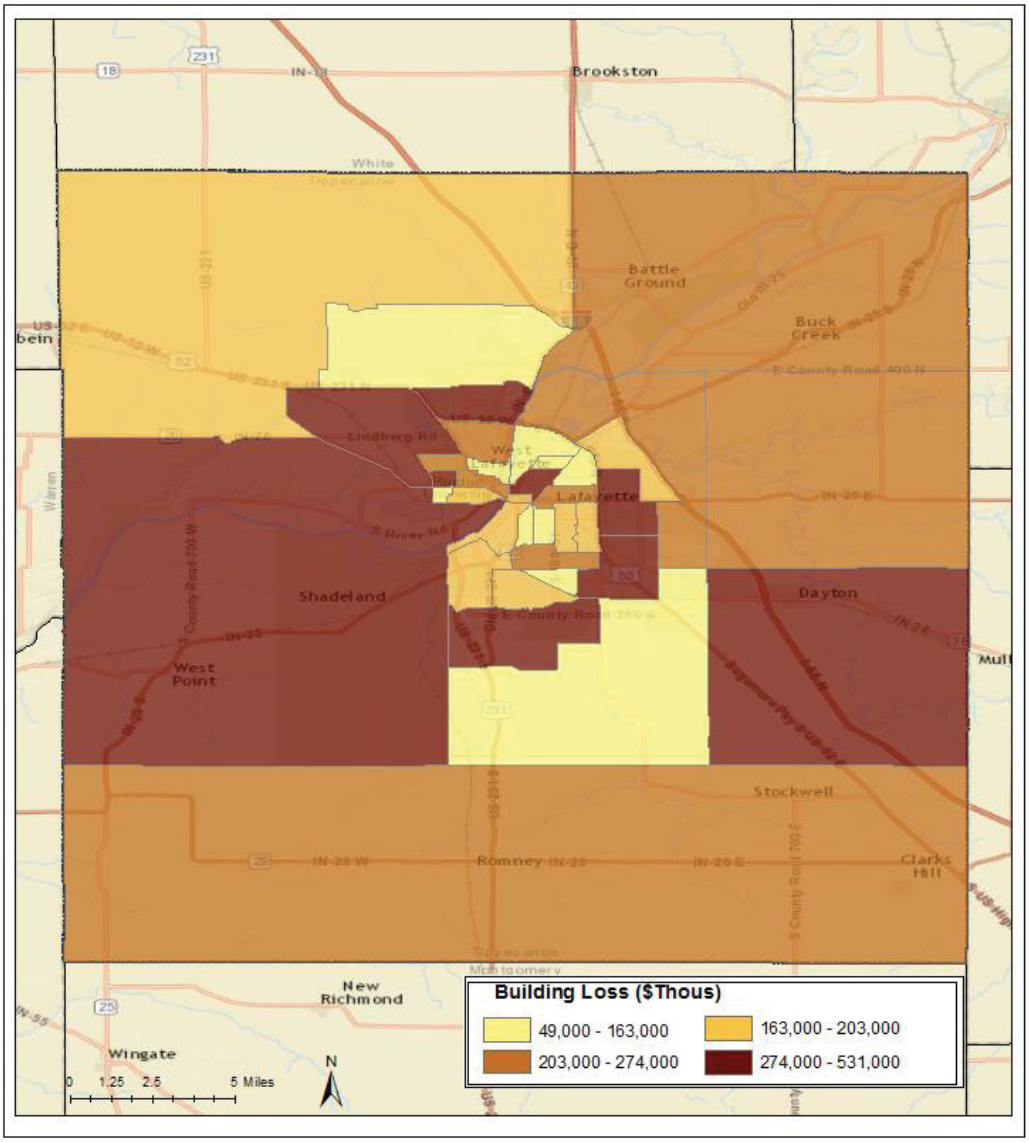
Table 19: Probabilistic 500-Year Scenario-Damage Counts by Building Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	291	0.62	18	0.76	8	1.17	1	1.58	0	0.98
Commercial	2,443	5.19	139	6.02	52	8.05	8	10.52	1	7.68
Education	104	0.22	6	0.26	2	0.36	0	0.45	0	0.51
Government	61	0.13	3	0.13	1	0.18	0	0.20	0	0.23
Industrial	628	1.33	36	1.55	14	2.18	2	2.83	0	1.74
Other Residential	9,321	19.79	547	23.65	180	27.69	15	19.76	1	17.65
Religion	258	0.55	15	0.66	6	0.92	1	1.23	0	1.14
Single Family	33,988	72.17	1,550	66.97	387	59.45	48	63.43	5	70.08
Total	47,092		2,315		651		76		7	

Table20: Probabilistic 500-Year Scenario-Building Losses in Millions of Dollars

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.00	0.18	2.01	0.09	0.20	2.47
	Capital-Related	0.00	0.08	1.65	0.05	0.05	1.83
	Rental	0.54	1.07	1.25	0.04	0.07	2.97
	Relocation	1.98	0.73	1.93	0.18	0.63	5.44
	Subtotal	**2.52**	**2.06**	**6.83**	**0.36**	**0.94**	**12.72**
Capital Stock Losses							
	Structural	3.53	1.93	1.97	0.39	0.56	8.37
	Non_Structural	7.05	4.50	2.93	0.58	0.91	15.97
	Content	1.07	0.66	1.13	0.34	0.35	3.55
	Inventory	0.00	0.00	0.04	0.08	0.01	0.13
	Subtotal	**11.65**	**7.09**	**6.07**	**1.39**	**1.82**	**28.02**
	Total	**14.17**	**9.15**	**12.90**	**1.76**	**2.76**	**40.74**

Figure 22: Probabilistic 500-Year Scenario-Building Losses in Thousands of Dollars



Essential Facility Damage

Before the earthquake, the region had 3,006 care facility beds available for uses. On the day of the earthquake, the model estimates that 2,667 care facility beds (89%) are available for use by patients already in medical care facilities and those injured by the earthquake. After one week, 95% of the beds will be back in service. By day 30, 99% will be operational.

Table 21: Probabilistic 500-Year Essential Facility Damage

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	67	0	0	67
Schools	56	0	0	56
EOCs	1	0	0	1
PoliceStations	11	0	0	11
FireStations	23	0	0	23

Annualized Loss Earthquake Scenario

The annualized loss earthquake scenario produced negligible losses.

Future Development Trends and Vulnerability to Future Assets/Infrastructure for Earthquake Hazard

Due to the unpredictability of this hazard, all buildings and infrastructure in Tippecanoe County are at risk of damage including temporary or permanent loss of function. For earthquakes non-reinforced structures are more vulnerable to damages. New development vulnerability will be minimal due to new construction codes coupled with the low earthquake probability.

Hazardous Materials Release Hazard

The state of Indiana has numerous active transportation lines that run through many of its counties. Active railways transport harmful and volatile substances between our borders every day. The transportation of chemicals and substances along interstate routes is commonplace in Indiana. The rural areas of Indiana have considerable agricultural commerce, creating a demand for fertilizers, herbicides, and pesticides to be transported along rural roads. Finally, Indiana is bordered by two major rivers and Lake Michigan. Barges transport chemicals and substances along these waterways daily. These factors increase the chance of hazardous material releases and spills throughout the State of Indiana.

The release or spill of certain substances can cause an explosion. Explosions result from the ignition of volatile products such as petroleum products, natural and other flammable gases, hazardous materials/chemicals, dust, and bombs. An explosion potentially can cause death, injury, and property damage. In addition, a fire routinely follows an explosion, which may cause further damage and inhibit emergency response. Emergency response may require fire, safety/law enforcement, search and rescue, and hazardous materials units.

Geographic Location

There are a number of major transportation routes in Tippecanoe County including an interstate, several state and US roads, and fairly extensive railway system.

Hazard Extent

There are 105 hazardous materials facilities in Tippecanoe County.

Vulnerability Analysis for Hazardous Materials Release

Hazardous material impacts are an equally distributed threat across the entire jurisdiction; therefore the entire county is vulnerable to a hazardous material release and can expect the same impacts within the affected area. The main concern during a release or spill is the population affected. This plan will therefore consider all buildings located within the county as vulnerable.

Facilities

All facilities and communities within the county are at risk. A critical facility will encounter many of the same impacts as any other building within the jurisdiction. These impacts include structural failure due to fire or explosion and loss of function of the facility (e.g., a damaged or chemically-contaminated police station will no longer be able to serve the community).

Building Inventory

During a hazardous material release, the types of infrastructure that could be impacted include roadways, utility lines/pipes, railroads and bridges. The release or spill of certain substances can cause an explosion. Explosions result from the ignition of volatile products such as petroleum products, natural and other flammable gases, hazardous materials/chemicals, dust, and bombs. An explosion

potentially can cause death, injury, and property damage. In addition, a fire routinely follows an explosion, which may cause further damage and inhibit emergency response.

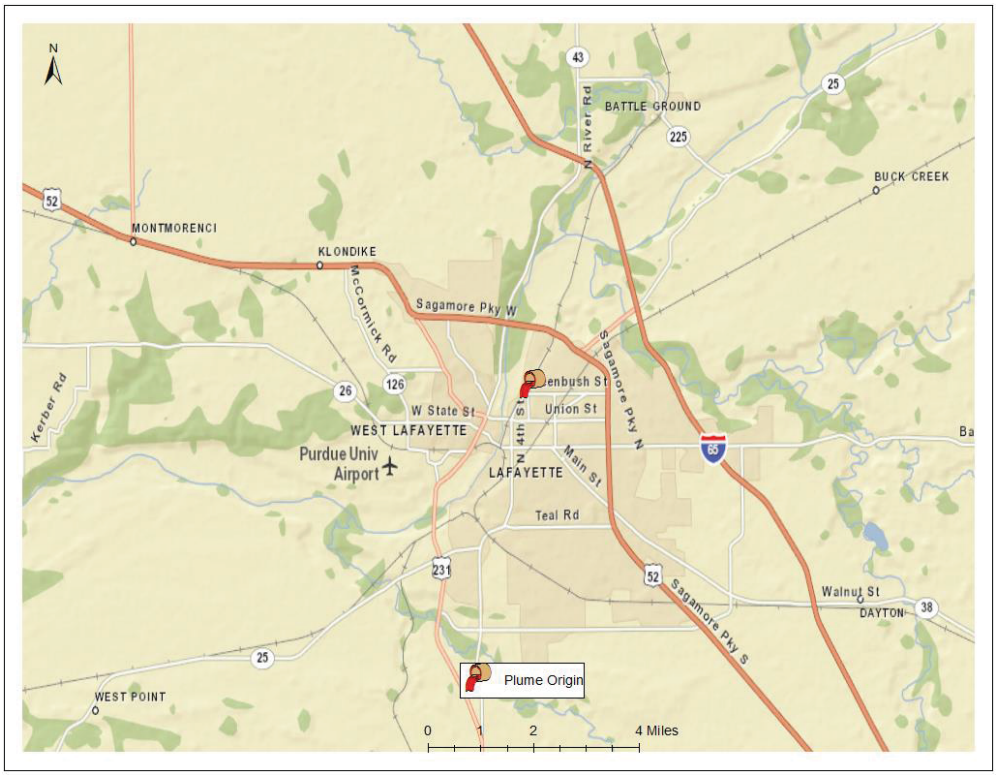
GIS Hazardous Materials Release Analysis

The U.S. EPA's ALOHA (Areal Locations of Hazardous Atmospheres) model was utilized to assess the area of impact for an ammonia release on railroad running across Lafayette community, adjacent Canal Road and Greenbush Street.

Anhydrous ammonia is a clear colorless gas with a strong odor. Contact with the unconfined liquid can cause frostbite. The gas is generally regarded as nonflammable but can burn within certain vapor concentration limits with strong ignition. The fire hazard increases in the presence of oil or other combustible materials. Vapors from an anhydrous ammonia leak initially hug the ground. Prolonged exposure of containers to fire or heat may cause violent rupturing and rocketing. Long-term inhalation of low concentrations of the vapors or short-term inhalation of high concentrations has adverse health effects. Anhydrous ammonia is generally used as a fertilizer, a refrigerant, and in the manufacture of other chemicals.

ALOHA is a computer program designed especially for use by people responding to chemical accidents, as well as for emergency planning and training. Anhydrous ammonia is a common chemical used in industrial operations and can be found in either liquid or gas form. Rail and truck tankers commonly haul ammonia to and from facilities. For this scenario, moderate atmospheric and climatic conditions with a slight breeze from the west were assumed. The target area was chosen due to its proximity to densely populated areas. The geographic area covered in this hypothetical analysis is depicted in Figure 23.

Figure 23: Location of Chemical Release



The ALOHA atmospheric modeling parameters, depicted in Figure 24, were based upon a west northwest wind speed of 13 MPH. The temperature was 12.2°F with 64% humidity and cloudy skies.

The source of the chemical spill is a cylindrical-shaped tank. The diameter of the tank was set to 8 feet and the length set to 33 feet (12,408 gallons). At the time of its release, it was estimated that the tank was 100% full. The Ammonia in this tank is in its liquid state. This release was based on a leak from a 2.5 foot diameter hole, 12 inches above the bottom of the tank.

Figure 64: ALOHA Plume Modeling Parameters

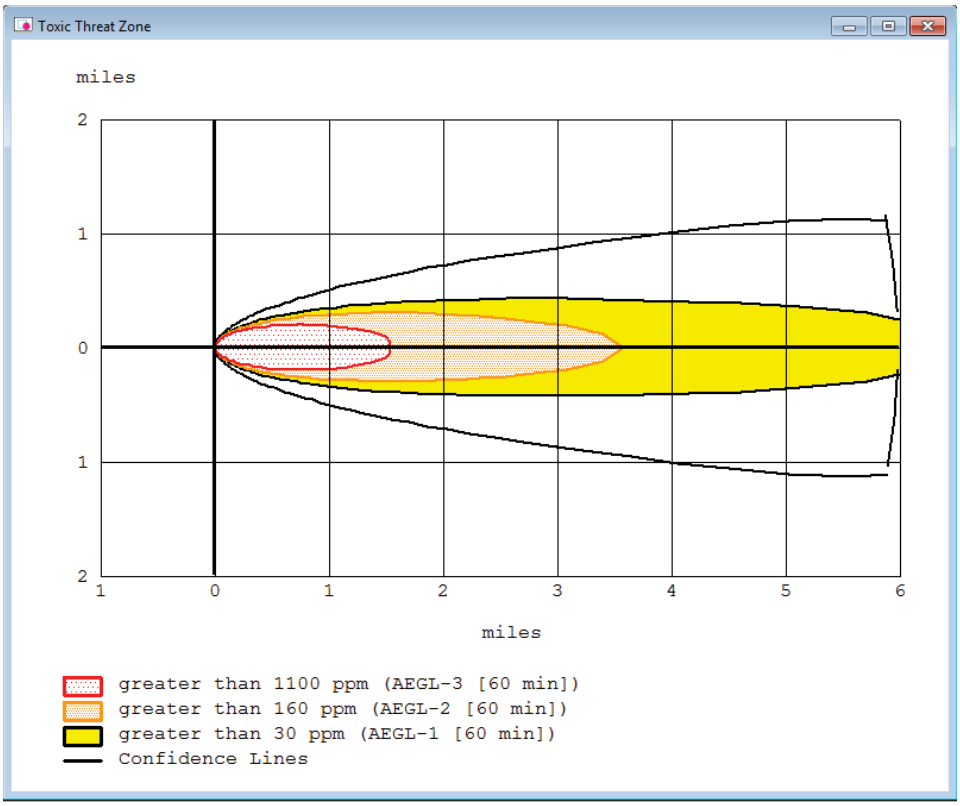
```
SITE DATA:
  Location: TIPPECANOE COUNTY, IN, INDIANA
  Building Air Exchanges Per Hour: 1.02 (sheltered single storied)
  Time: February 18, 2015  1256 hours EST (using computer's clock)

CHEMICAL DATA:
  Chemical Name: AMMONIA                  Molecular Weight: 17.03 g/mol
  AEGL-1 (60 min): 30 ppm   AEGL-2 (60 min): 160 ppm   AEGL-3 (60 min): 1100 ppm
  IDLH: 300 ppm      LEL: 150000 ppm     UEL: 280000 ppm
  Ambient Boiling Point: -28.8° F
  Vapor Pressure at Ambient Temperature: greater than 1 atm
  Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)
  Wind: 13 miles/hour from WNW at 3 meters
  Ground Roughness: urban or forest      Cloud Cover: 7 tenths
  Air Temperature: 12.2° F               Stability Class: D
  No Inversion Height                    Relative Humidity: 64%

SOURCE STRENGTH:
  Leak from hole in horizontal cylindrical tank
  Flammable chemical escaping from tank (not burning)
  Tank Diameter: 8 feet                  Tank Length: 33 feet
  Tank Volume: 12,408 gallons
  Tank contains liquid                   Internal Temperature: 12.2° F
  Chemical Mass in Tank: 33.8 tons       Tank is 100% full
  Circular Opening Diameter: 2.5 feet
  Opening is 1.00 feet from tank bottom
  Release Duration: 1 minute
  Max Average Sustained Release Rate: 1,120 pounds/sec
     (averaged over a minute or more)
  Total Amount Released: 67,148 pounds
  Note: The chemical escaped as a mixture of gas and aerosol (two phase flow).

THREAT ZONE:
  Model Run: Heavy Gas
  Red   : 1.5 miles --- (1100 ppm = AEGL-3 [60 min])
  Orange: 3.6 miles --- (160 ppm = AEGL-2 [60 min])
  Yellow: greater than 6 miles --- (30 ppm = AEGL-1 [60 min])
```

Acute Exposure Guideline Levels (AEGLs) are intended to describe the health effects on humans as a result of once-in-a-lifetime or rare exposure to airborne chemicals. The National Advisory Committee for AEGLs is developing these guidelines to help national and local authorities, as well as private companies, deal with emergencies involving spills or other catastrophic exposures. As the substance moves away from the source, the level of substance concentration decreases. Each color-coded area depicts a level of concentration measured in parts per million (ppm). The image in Figure 25 depicts the plume footprint generated by ALOHA in ArcGIS.

- AEGL 3: Above this airborne concentration of a substance, it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death. The red buffer (>= 1100 ppm) extends no more than 4.8 miles from the point of release after one hour.
- AEGL 2: Above this airborne concentration of a substance, it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape. The orange buffer (>= 160 ppm) extends no more than six miles from the point of release after one hour.
- AEGL 1: Above this airborne concentration of a substance, it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic nonsensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure. The yellow buffer (>= 30 ppm) extends more than six miles from the point of release after one hour.

According to the ALOHA parameters, approximately 145,225 pounds of material would be released per minute. The image in Figure 26 depicts the plume footprint generated by ALOHA.

Figure 25: Plume Footprint Generated by ALOHA

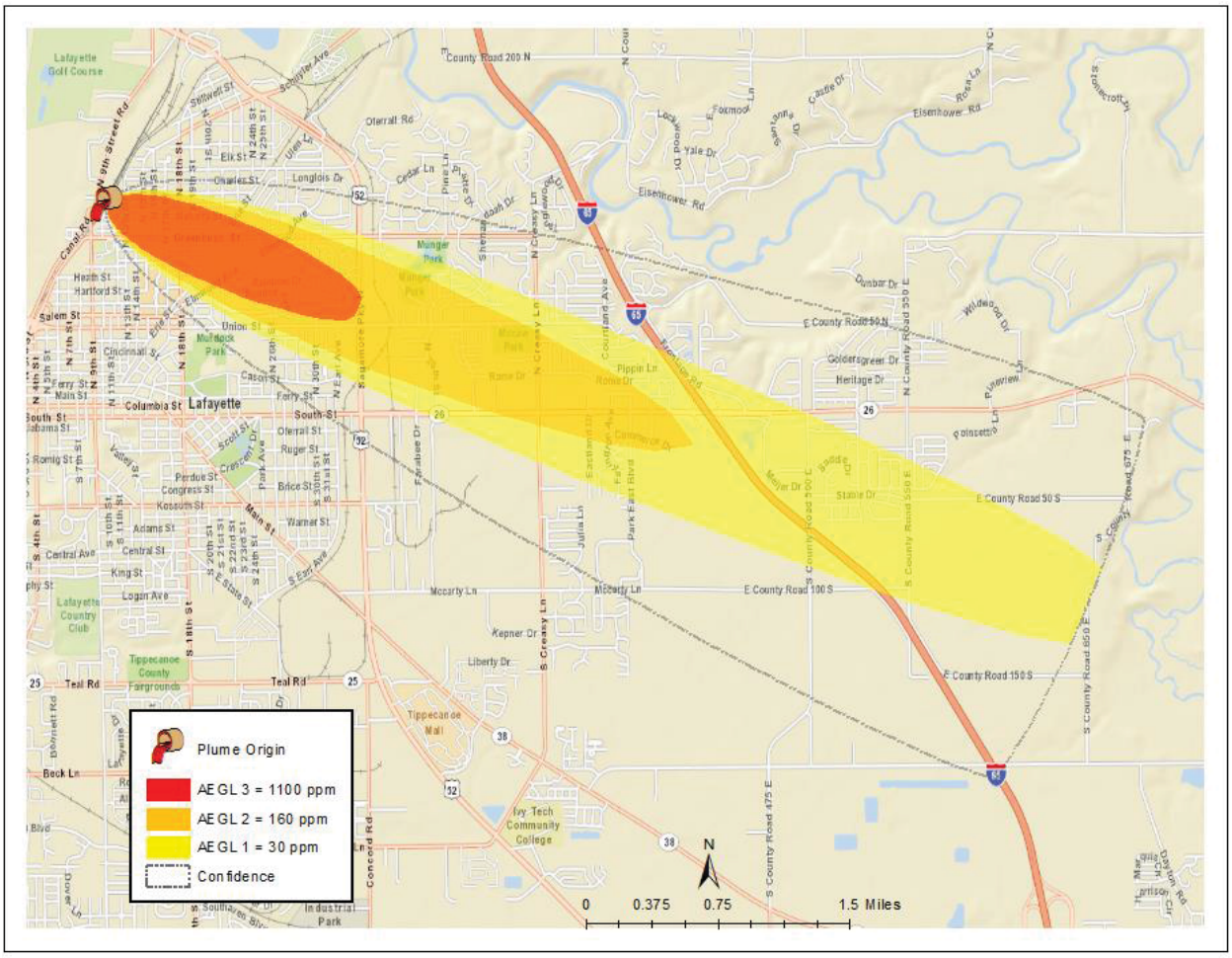


As the substance moves away from the source, the level of substance concentration decreases. Each color-coded area depicts a level of concentration measured in parts per million (ppm). For the purpose of clarification, this report will designate each level of concentration as a specific zone. The zones are as follows:

- **Zone 1** (AEGL-3): The red buffer (>=1100 ppm) extends no more than 4.8 miles from the point of release after one hour.
- **Zone 2** (AEGL-2): The orange buffer (>=160 ppm) extends no more than six miles from the point of release after one hour.
- **Zone 3** (AEGL-1): The yellow buffer (>=30 ppm) extends more than six miles from the point of release after one hour.
- **Confidence Lines**: The dashed lines depict the level of confidence in which the exposure zones will be contained. The ALOHA model is 95% confident that the release will stay within this boundary.

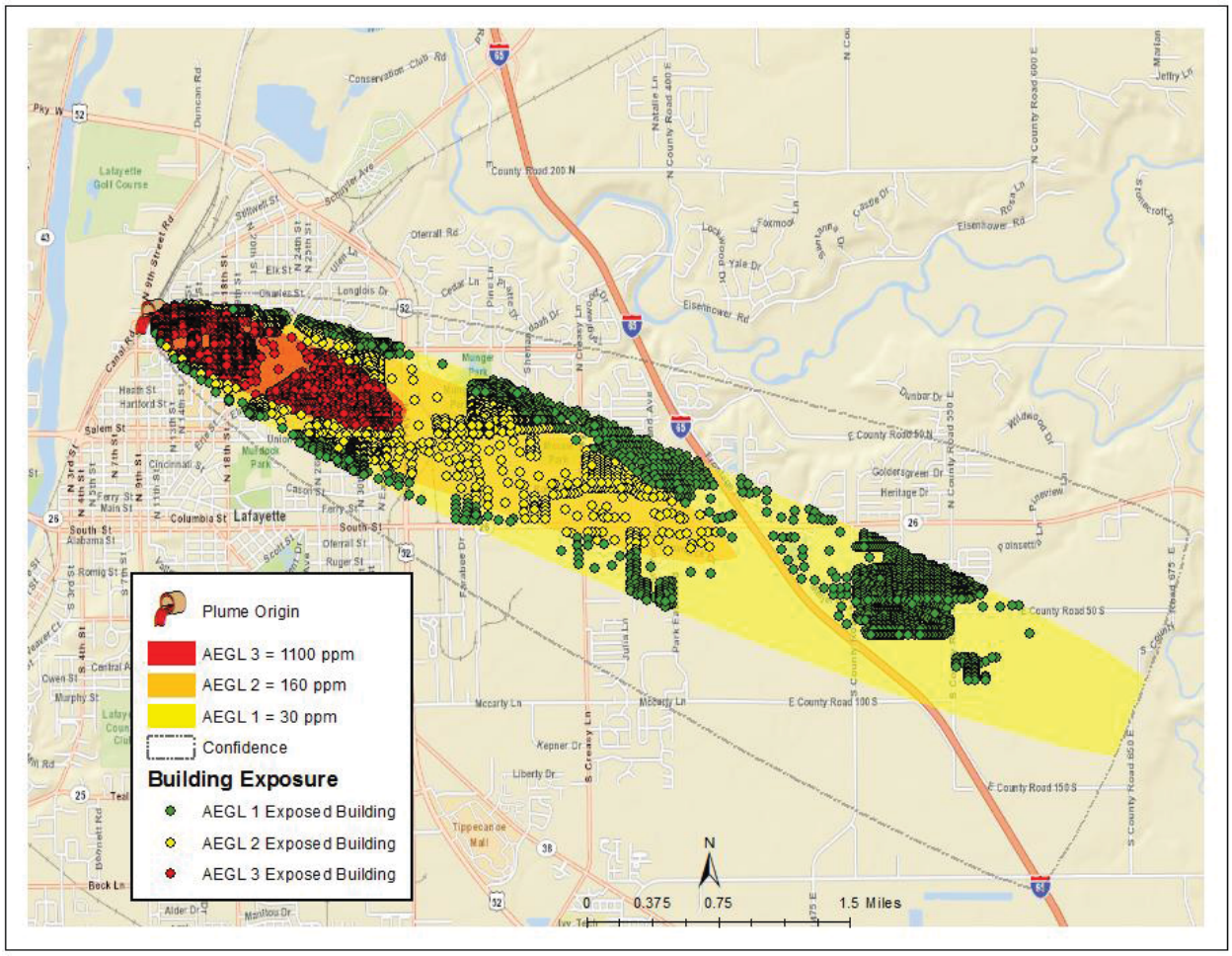
The image in Figure 26 depicts the plume footprint generated by ALOHA.

Figure26: ALOHA Plume Footprint Overlaid in ArcGIS



The Tippecanoe County Building Inventory was added to ArcMap and overlaid with the plume footprint. The Building Inventory was then intersected with each of the four footprint areas to classify each point based upon the plume footprint in which it is located. Figure 27 depicts the Tippecanoe County Building Inventory after the intersect process.

Figure 27: Tippecanoe County Building Inventory Classified By Plume Footprint



Results

By summing the building inventory within all AEGL zones (Zone 1: 30 ppm, Zone 2: 160 ppm, and Zone 3: 1100 ppm), the GIS overlay analysis predicts that as many as 3,197 buildings and 7,993 people could be exposed. The population is estimated based on 2.5 people per residence.

Building Inventory Exposure

The results of the analysis against the Building Inventory points are depicted in the following tables. Table 22 summarizes the results of the chemical spill by combining all AEGL zones.

Table 22: Estimated Exposure for all Zones including Confidence Area (all ppm)

Occupancy	Population	Building Counts	Building Exposure
Residential	7,993	2,879	396,316,932
Commercial	0	284	312,527,090
Industrial	0	4	7,198,392
Agriculture	0	0	0
Religious	0	27	28,411,210
Government	0	3	2,085,150
Education	0	0	0
Total	**7,993**	**3,197**	**746,538,774**

Tables 23 through 25 summarize the results of the chemical spill for each zone separately. Values represent only those portions of each zone that are not occupied by other zones.

Table 23: Estimated Exposure for Zone 3 (1100 ppm)

Occupancy	Population	Building Counts	Building Exposure
Residential	2,298	881	107,127,295
Commercial	0	27	23,795,280
Industrial	0	0	0
Agriculture	0	0	0
Religious	0	11	14,100,140
Government	0	0	0
Education	0	0	0
Total	**2,298**	**919**	**145,022,715**

Table 24: Estimated Exposure for Zone 2 (160 ppm)

Occupancy	Population	Building Counts	Building Exposure
Residential	4,300	1,520	211,492,573
Commercial	0	177	157,933,660
Industrial	0	3	5,106,660
Agriculture	0	0	0
Religious	0	18	20,401,900
Government	0	2	1,149,770
Education	0	0	0
Total	**4,300**	**1,720**	**396,084,563**

Table 25: Estimated Exposure for Zone 1 (30 ppm)

Occupancy	Population	Building Counts	Building Exposure
Residential	5,120	1,730	203,075,462
Commercial	0	284	312,527,090
Industrial	0	4	7,198,392
Agriculture	0	0	0
Religious	0	27	28,411,210
Government	0	3	2,085,150
Education	0	0	0
Total	**5,120**	**2,048**	**553,297,304**

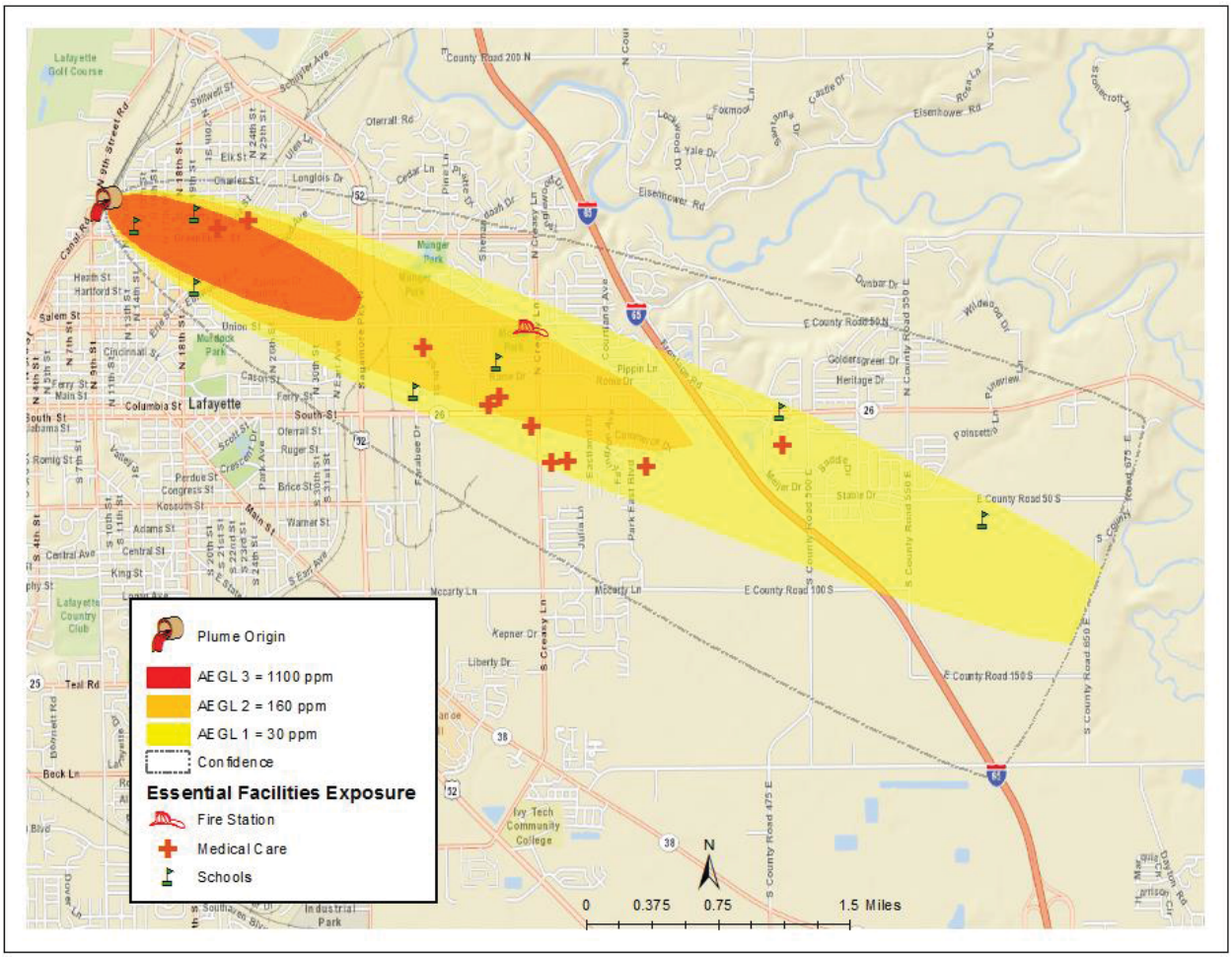
Essential Facilities Exposure

There are 10 care facilities, 7 schools and 1 fire station affected by the chemical spill. Figure 28 depicts the essential facilities exposed to Ammonia spill plume. The affected facilities are identified in in Table 26, and their geographic locations are shown in Figure 4.

Table 26: Estimated Essential Facilities Affected

Name
BRIGHTSTAR OF LAFAYETTE INDIANA
PAY LESS J 843
Sams Club
Walgreens
WAL MART 1547
ADDUS HOMECARE
MARSH 47
WABASH CENTER INC
WELLBOUND OF LAFAYETTE
MEIJER 137
LFD Station
FAITH CHRISTIAN SCHOOL
New Community School
Linwood Elementry school
Wyandotte Elementary School
Follow the Child Montessori
T C Harris School at IDTC LAF
Saint Lawrence Elementary School

Figure 28: Tippecanoe County Essential Facilities Classified By Plume Footprint

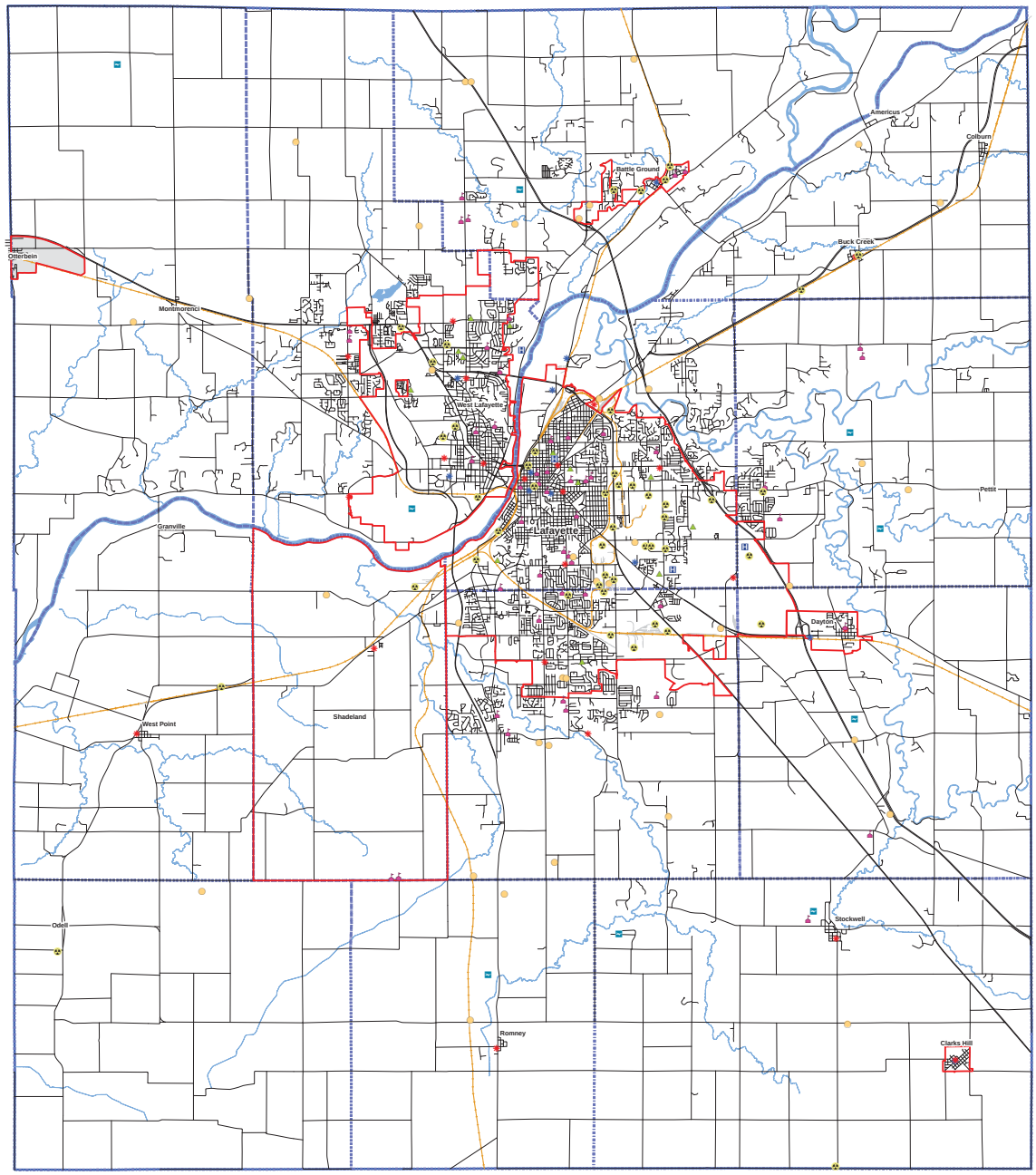


Future Development Trends and Vulnerability to Future Assets/Infrastructure for Hazardous Material Release Hazard

Due to the unpredictability of this hazard, all buildings and infrastructure in Tippecanoe County are at risk of damage including temporary or permanent loss of function.

APPENDIX E – ADDITIONAL MAPS

COUNTY WIDE CRITICAL FACILITIES



BASE MAP

- Cities
- RoadSegments

RAIL

- Primary Rail
- Secondary Rail
- Abandoned Rail
- Townships

ID	Hazardous Material Handler Name
0	AT&T (previously: Indiana Bell Telephone Facility)
1	ALCOA Lafayette Operations
2	Battle Ground Water Wells and Treatment
3	Battle Ground Water Wells and Treatment
4	Battle Ground Water Wells and Treatment
5	Cargill INC
6	Caterpillar, INC
7	Caterpillar Logistics-Kepner Facility
8	Caterpillar Logistics
9	Caterpillar Logistics
10	Century Tel
11	Ceres Solutions 295 (Arcmark)
12	Coca Cola Bottling
13	Comcast
14	Crop Production Services 496 (previously Royster Clark)
15	Crop Production Services 455
16	Crop Production Services 420
17	Crown Castle USA
18	Evonik Tippecanoe Labs
19	Great Lakes Chemical Corporation (a Chemtura Company)
20	Hanson Cold Storage
21	Home Depot #3034
22	Ice Cream Specialties
23	Industrial Plating
24	Perry Chemical
25	Purdue University
26	Rea Magnet Wire
27	Sams Club
28	Sunbelt Rentals #309
29	State Farm Mutual Insurance Company
30	Subaru of Indiana
31	Tate and Lyle Sagamore operations
32	Tate and Lyle Lafayette South Plant
33	Toyota Tsusho America
34	TRW Automotive
35	Verizon Lafayette NW Co
36	Frontier Communications (formerly Verizon Lafayette East)
37	Verizon Lafayette South Co
39	Verizon Lafayette Main Co
39	Verizon-Boilers
40	Verizon Lafayette East RMT
41	Verizon Creasy Lane
42	Verizon Wireless University Parking Garage
43	Wabash National South Plant
44	Wabash National
45	Waste Management
46	Westland Corp (formerly Ceres Solutions 235)

ID	Airport Name
0	WILDCAT AIR LANDING AREA
1	PURDUE UNIVERSITY
2	TIMBER HOUSE
3	WYANDOTTE
4	ETTER
5	SKYCLIFF
6	SUTTON
7	FILLR
8	DIANNE

ID	Nursing Home Name
0	Heritage Healthcare Nursing Facility
1	Greenhouse at West Lafayette
2	George Davis Manor
3	Indiana Developmental Training Center
4	Regency Place of Lafayette
5	Review at Village
6	Saint Anthony Healthcare
7	Saint Mary Healthcare Center
8	University Place
9	Bickford Assisted Living
10	Westminster Village
11	Creasy Springs
12	Sycamore Springs

ID	Communications Tower Name
0	CELL TOWER
1	WBAA-AM 920
2	WASK 1450
3	WLFF CH 227
4	WGLM CH 264
5	WJEF CH 220
6	WBAA-FM CH 267
7	WASK-FM CH 254
8	WKHF CH 228
9	WOWB CH 275
10	CELL TOWER
11	CELL TOWER
12	CELL TOWER
13	CELL TOWER
14	CELL TOWER

CRITICAL FACILITIES

- Airports
- Hazardous Material Handler
- Communications Tower
- Hospital
- School
- Fire Station
- Senior Living
- Police Station

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List of Hazardous materials compiled by Lafayette LEPC

ID	School Name
0	Amelia Earhart Elementary School
1	First Christian School
2	Burnet Creek Elementary School
3	Harrison Senior High School
4	Cumberland Elementary School
5	Happy Hollow Elementary School
6	West Lafayette Junior/Senior High School
7	Vinton Elementary School
8	Oakland School
9	Miller School
10	Glenn Acres Elementary School
11	Sunnyside Junior High School
12	Murdock Elementary School
13	Jefferson High School
14	Central Catholic Junior/Senior High School
15	Cary Home for Children
16	Linne ood Elementary School
17	Miami Elementary School
18	Edgelea Elementary School
19	Lafayette Christian School
20	Tecumseh Junior High School
21	Klondike Middle School
22	Wea Ridge Elementary
23	Wea Ridge Middle School
24	Mayflower Mill Elementary School
25	McCutcheon High School
26	Dayton Elementary School
27	Wayview right Middle School
28	Cole Elementary School
29	Battleground Middle School
30	Southwestern Junior High School
31	Mintonye Elementary School
32	Battle Ground Elementary School
33	East Tipp Junior High School
34	Hershey Elementary School
35	Battle Ground Junior High School
36	Woodland Elementary
37	Klondike Elementary School
38	St Boniface Middle School
39	St Lawrence School
40	St Mary School
41	Purdue University
42	Ivy Tech Community College
43	First Assembly Christian Academy
44	Montessori School of Greater Lafayette
45	Pleasantview Christian School
46	Washington Elementary School
47	St Lames Lutheran
48	Ivy Tech
49	Wyandotte Elementary School

ID	Fire Station Names
0	Buck Creek
1	Randolph Twp
2	Wea Twp Community
3	West Point
4	Sheffield Twp
5	Tippecanoe Twp Vol
6	Clarks Hill Vol
7	Lauramie Twp Vol
8	City of Lafayette 1
9	City of Lafayette 2
10	City of Lafayette 3
11	City of Lafayette 5
12	City of Lafayette 6
13	City of Lafayette 7
14	City of Lafayette 8
15	City of Lafayette 9
16	Wabash Twp Vol
17	Wabash Twp Vol
18	West Lafayette
19	West Lafayette
20	Purdue University
21	Shadeland

ID	Hospital Name
0	St. Elizabeth Central Hospital
1	IUPDarion Hospital
2	Riverside Hospital
3	St. Elizabeth East Hospital

ID	Police Station Name
0	Dayton Tow n Marshal
1	Clarks Hill Tow n Marshal
2	Battle Ground Tow n Marshal
3	TSMA
4	Lafayette Police Department
5	West Lafayette Police Department
6	Purdue University Police
8	Indiana State Police Post
7	County Sheriff's Department
9	Indiana State Police Law Enforcement District 3
10	Lafayette Police
11	Community Corrections

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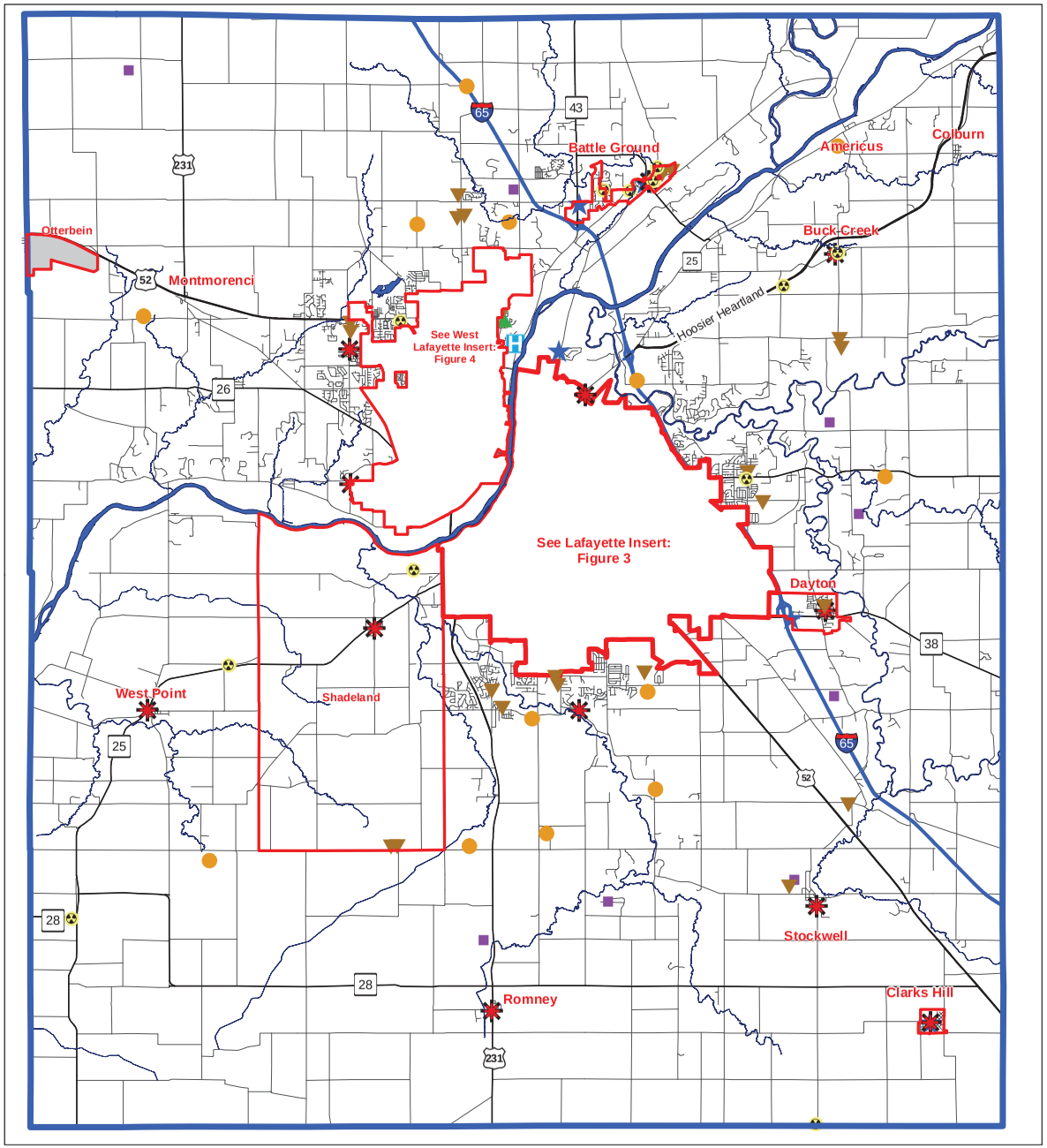

FIGURE 2

COUNTY WIDE CRITICAL FACILITIES

Legend

- Corporation Boundaries
- Municipality not Participating
- Airports
- Hazardous Material Handler
- Communications Tower
- Hospital
- School
- Fire Station
- Senior Living/Nursing Homes
- Police Station

0 2 4
Miles

NORTH

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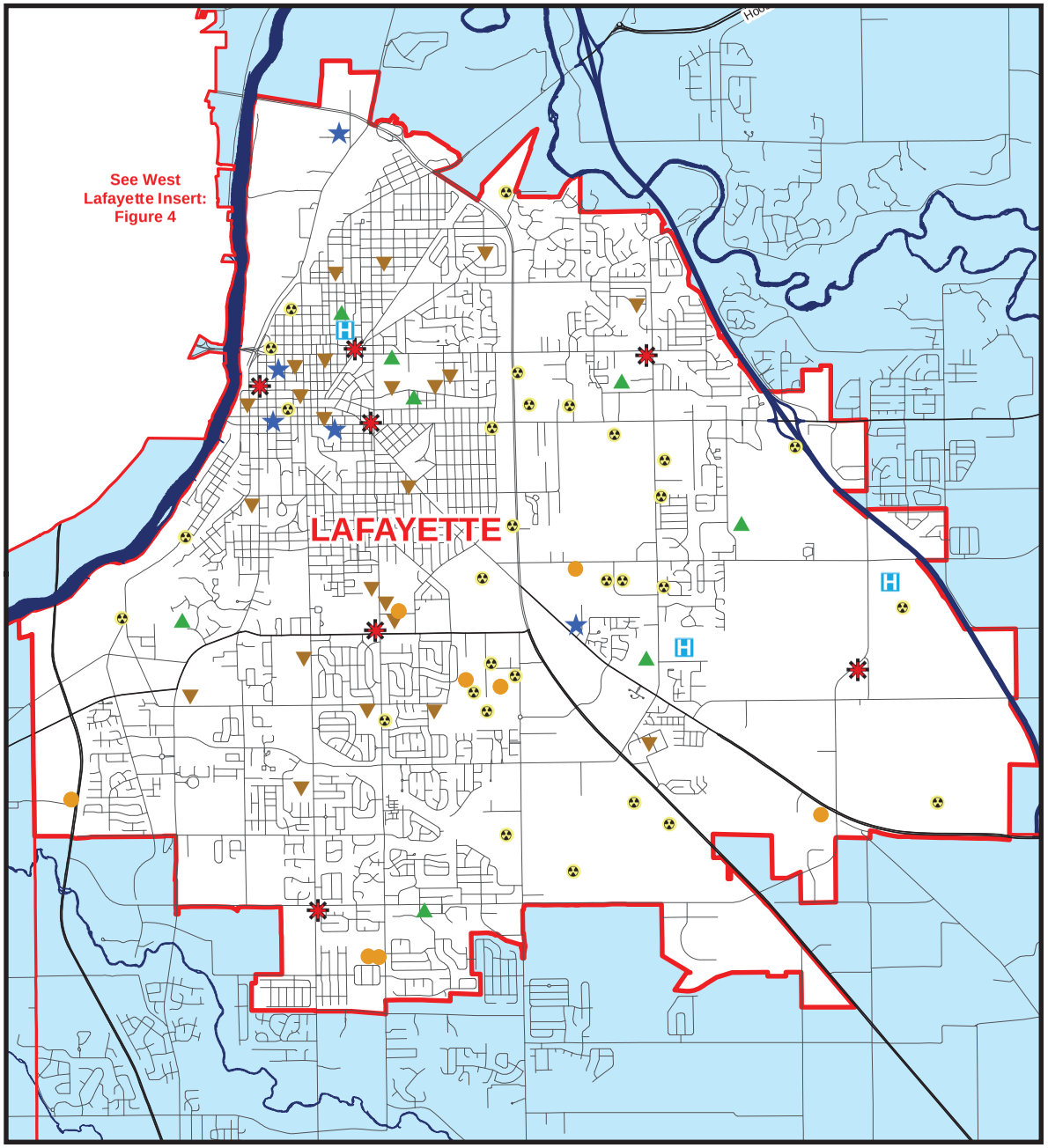

FIGURE 3

LAFAYETTE CRITICAL FACILITIES

Legend

- Airports
- Hazardous Material Handler
- Communications Tower
- Hospital
- School
- Fire Station
- Senior Living/Nursing Homes
- Police Station
- Corporation Boundaries
- Municipality not Participating

0 0.5 1
Miles

NORTH

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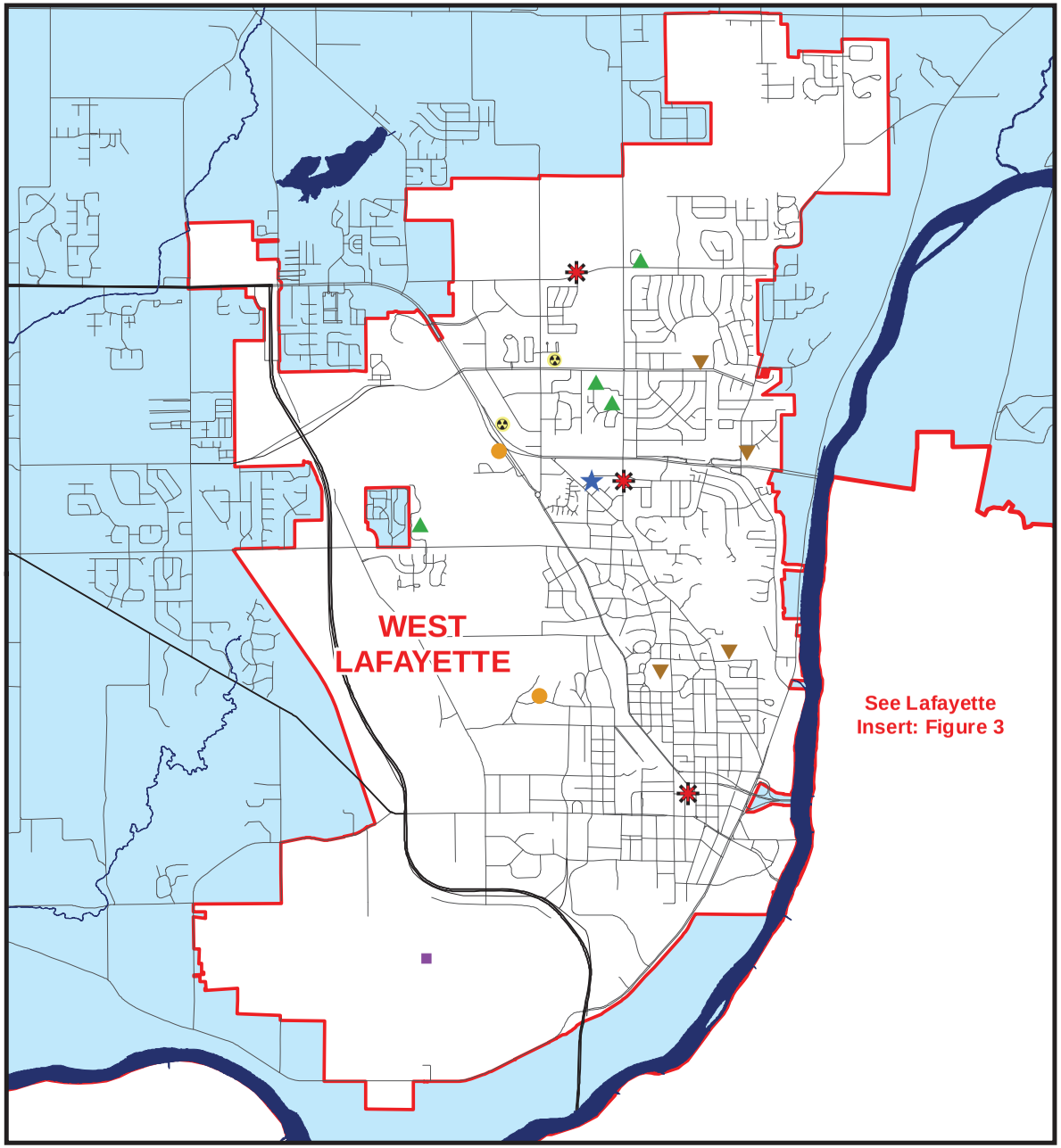

FIGURE 4

WEST LAFAYETTE CRITICAL FACILITIES

Legend

- Airports
- Hazardous Material Handler
- Communications Tower
- Hospital
- School
- Fire Station
- Senior Living/Nursing Homes
- Police Station
- Municipalities not Participating
- Corporation Boundaries

0 0.5 1
Miles

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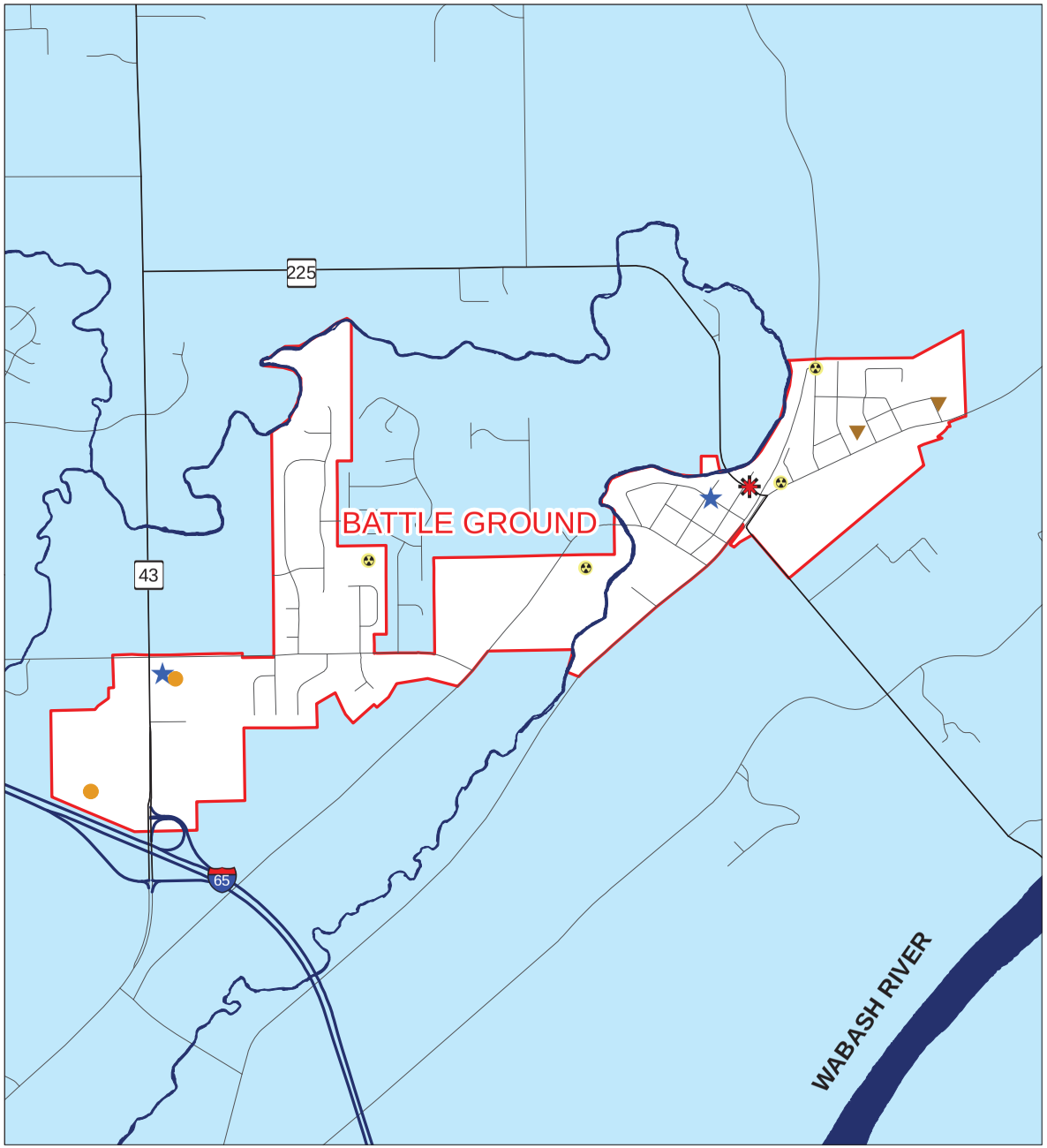

FIGURE 5

BATTLE GROUND CRITICAL FACILITIES

Legend

- Airports
- Hazardous Material Handler
- Communications Tower
- Hospital
- School
- Fire Station
- Senior Living/Nursing Homes
- Police Station
- Municipality not Participating
- Corporation Boundaries

0 1,200 2,400
Feet

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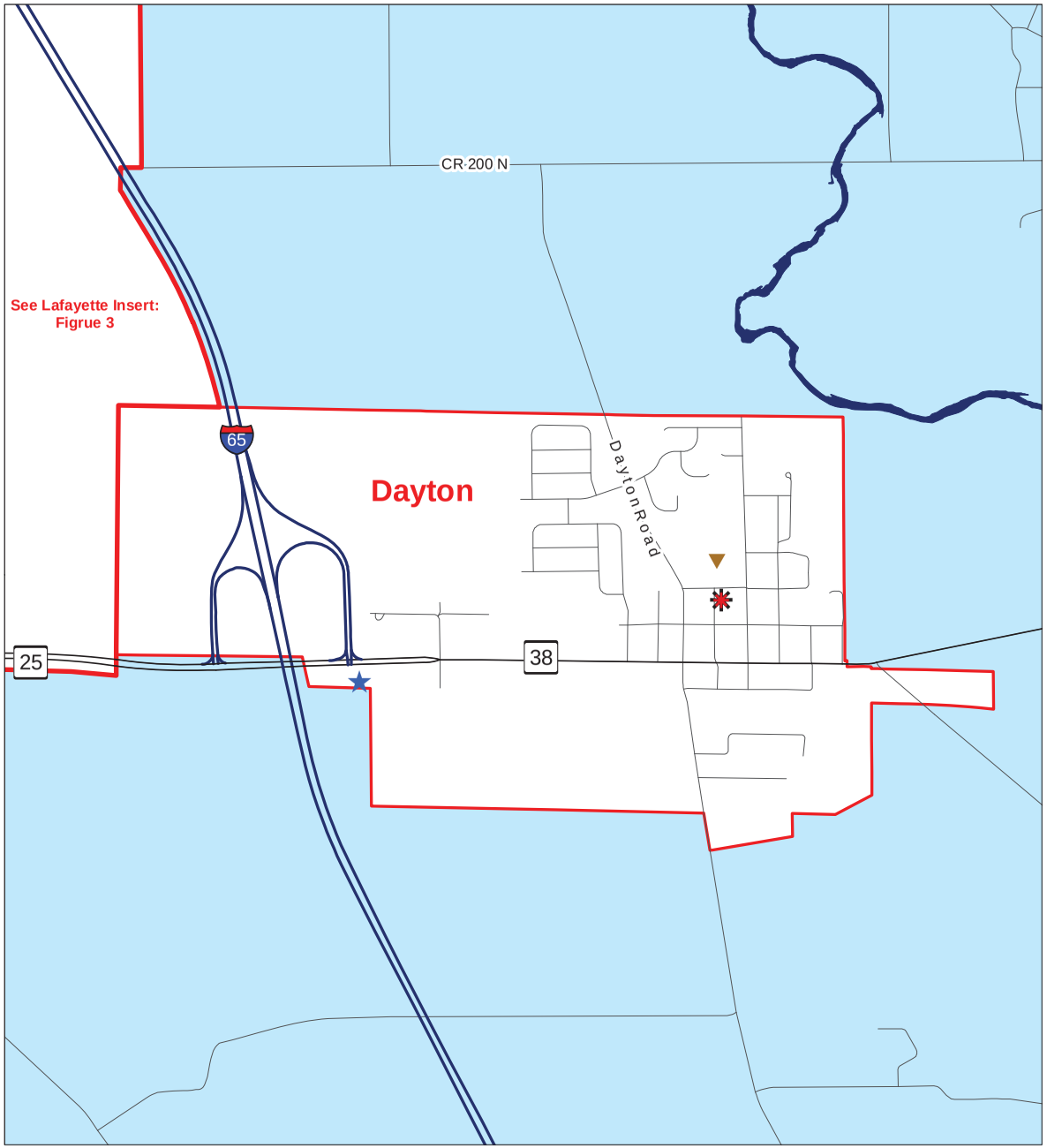

FIGURE 6

DAYTON CRITICAL FACILITIES

Legend

- Airports
- Hazardous Material Handler
- Communications Tower
- Hospital
- School
- Fire Station
- Senior Living/Nursing Homes
- Police Station
- Municipality not Participating
- Corporation Boundaries

0 1,250 2,500
Feet

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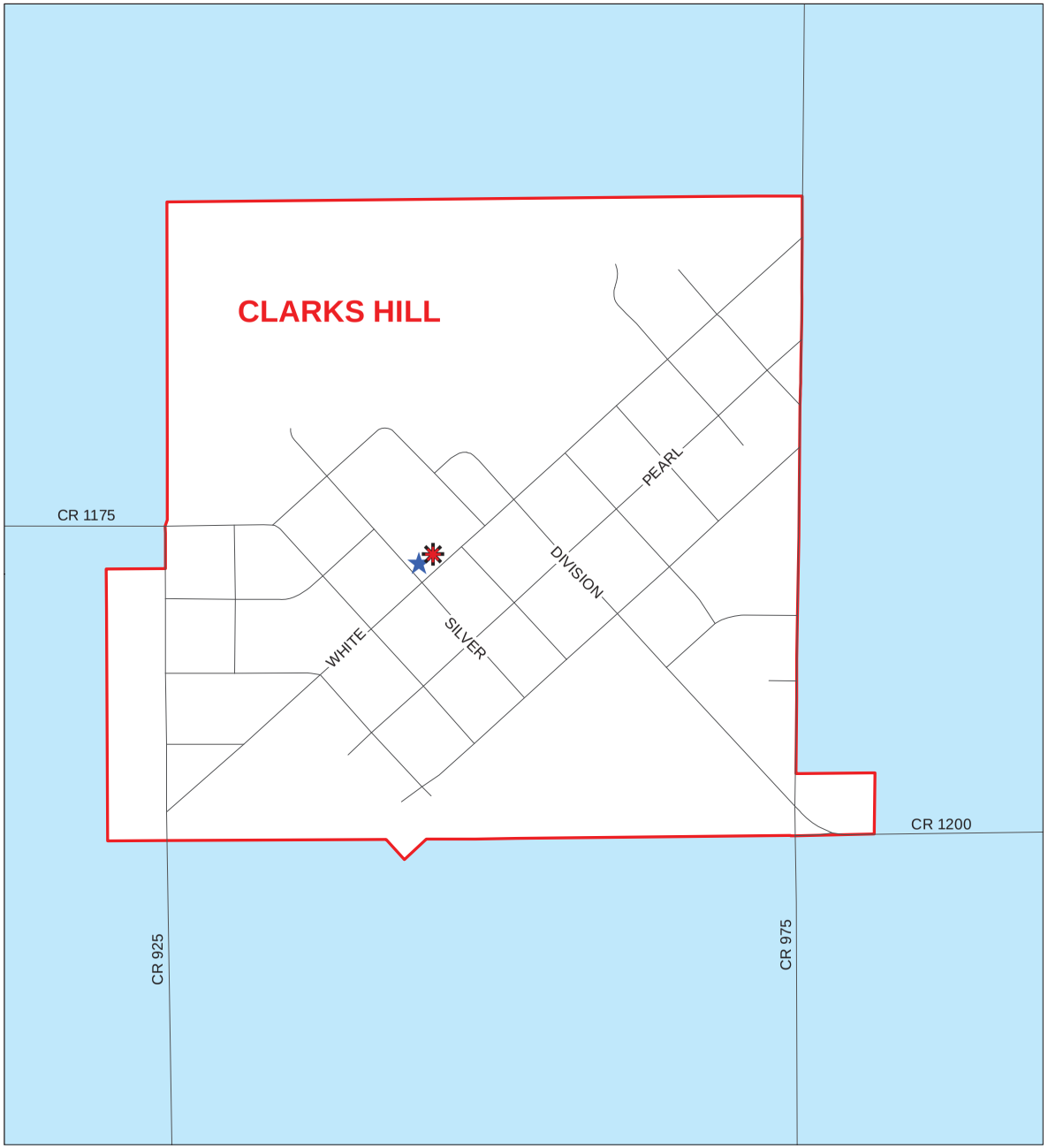

FIGURE 7

CLARKS HILL CRITICAL FACILITIES

Legend

- Airports
- Hazardous Material Handler
- Communications Tower
- Hospital
- School
- Fire Station
- Senior Living/Nursing Homes
- Police Station
- Municipality not Participating
- Corporation Boundaries

0 500 1,000
Feet

NORTH

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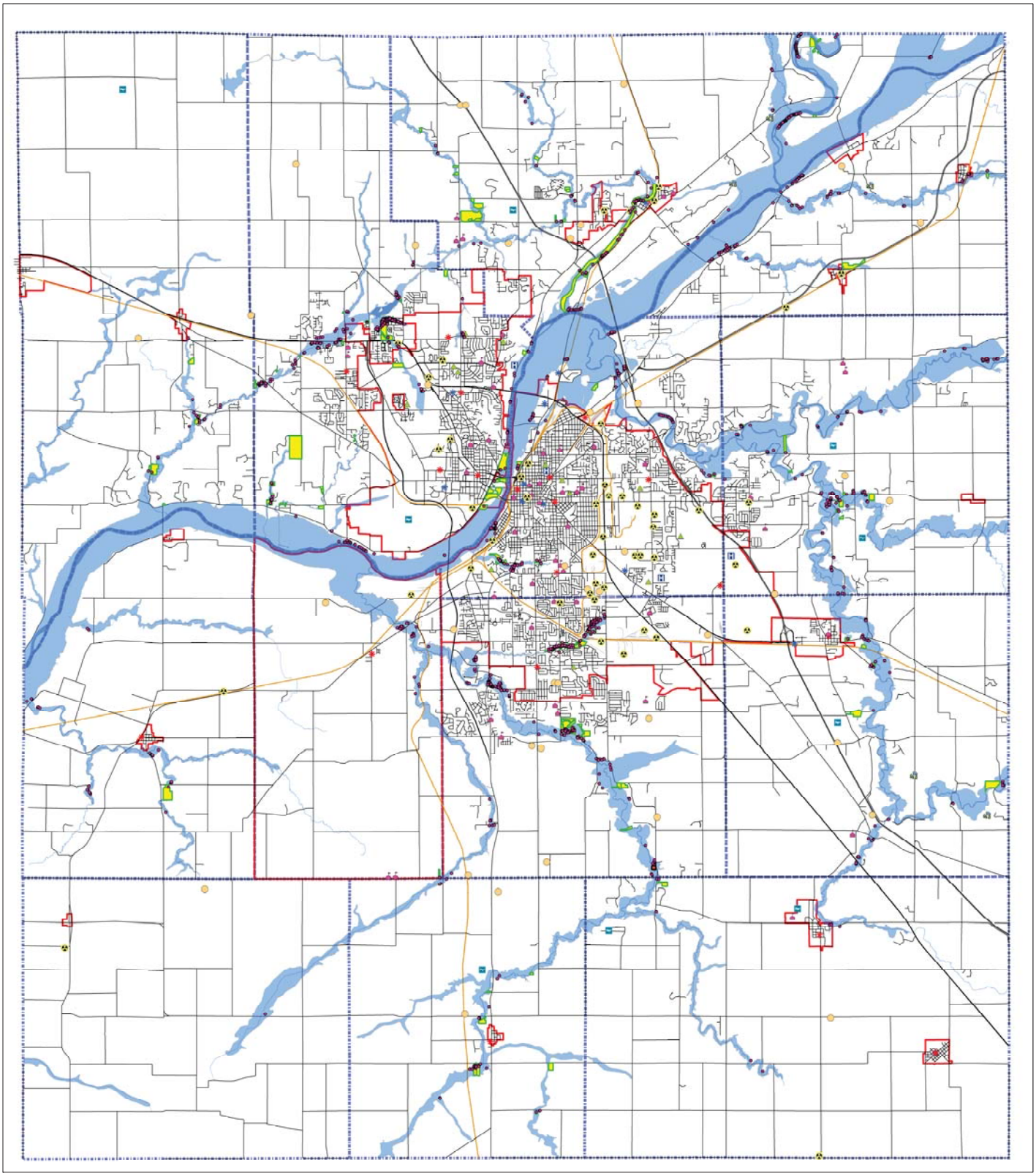
Structures in the Regulatory Flood Plain, USGS Stream Gauges, and Dams



BASE MAP

- RoadSegments
- Cities
- Townships

RAIL

- Primary Rail
- Secondary Rail
- Abandoned Rail

CRITICAL FACILITIES

- Airports
- Hazardous Material Handler
- Communications Tower
- Hospital
- School
- Fire Station
- Senior Living
- Police Station

FLOOD RELATED

- Flood Buyouts
- Stream Gages
- Structures in Special Flood Hazarad Areas
- Letter of Map Amendments
- Dams

FEMA FLOOD PLAIN

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Properties shown in the Flood Plain are a depiction of the FEMA FIRM Special Flood Hazard Area.

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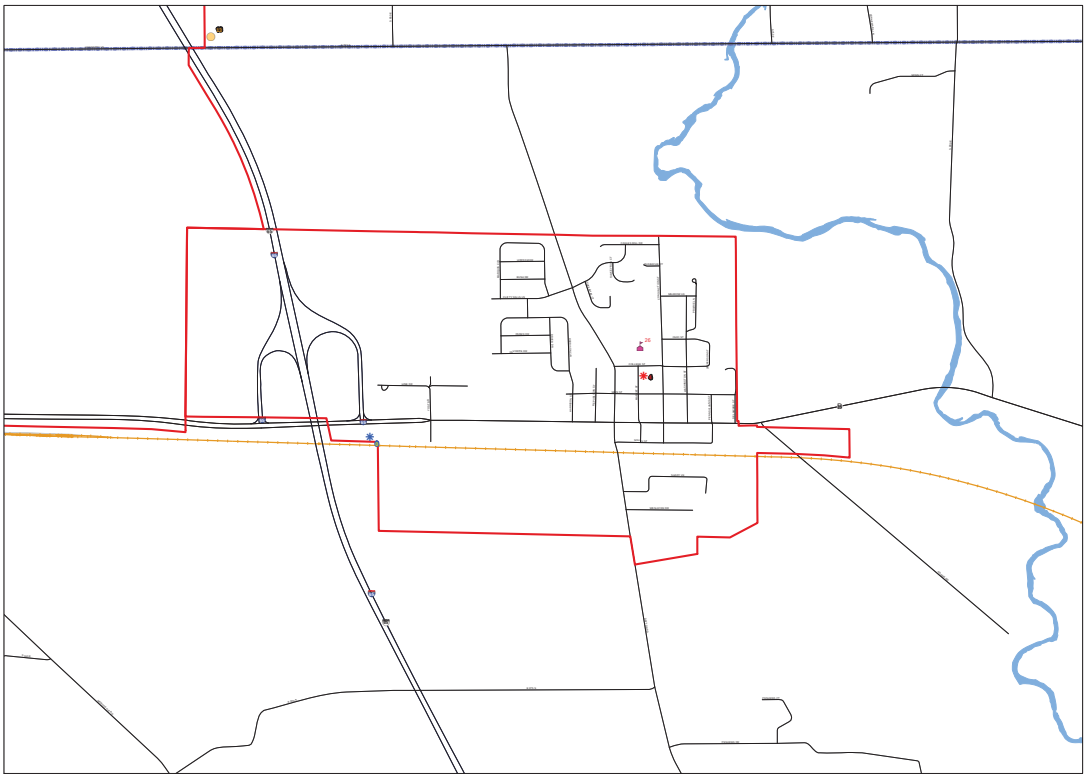
MUNICIPAL CRITICAL FACILITIES

DAYTON



ID	Police Station Name
0	Dayton Town Marshal
1	Clarks Hill Town Marshal
2	Battle Ground Town Marshal
3	TEMA
4	Lafayette Police Department
5	West Lafayette Police Department
6	Purdue University Police
8	Indiana State Police Post
7	County Sheriff's Department
9	Indiana State Police Law Enforcement District 3
10	Lafayette Police

ID	Hospital Name
0	St. Elizabeth Central Hospital
1	IuClarian Hospital
2	Riverside Hospital

ID	Communications Tower Name
0	CELL TOWER
1	WBAA 920
2	WASK 1450
3	WLFF CH 237
4	WGLM CH 294
5	WJEF CH 230
6	WBAA-FM CH 267
7	WASK-FM CH 254
8	WKHY CH 228
9	WXOB CH 275
10	CELL TOWER
11	CELL TOWER
12	CELL TOWER
13	CELL TOWER
14	CELL TOWER

ID	Airport Name
0	WILDCAT AIR LANDING AREA
1	PURDUE UNIVERSITY
2	TIMBER HOUSE
3	WYANDOTTE
4	ETTER
5	RATCLIFF
6	SUTTON
7	FELIX
8	DAHNKE

ID	Nursing Home Name
0	Heritage Healthcare Nursing Facility
1	Greentree at West Lafayette
2	George Davis Manor
3	Indiana Developmental Training Center
4	Regency Place of Lafayette
5	Rosewalk Village
6	Saint Anthony Healthcare
7	Saint Mary Healthcare Center
8	University Place
9	Bickford Assisted Living
10	Westminster Village
11	Creasy Springs
12	Sycamore Springs

ID	Fire Station Names
0	Buck Creek
1	Randolph Twp
2	Wea Twp Community
3	West Point
4	Sheffield Twp
5	Tippecanoe Twp Vol
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12	City of Lafayette 6
13	City of Lafayette 7
14	City of Lafayette 8
15	City of Lafayette 9
16	Wabash Twp Vol
17	Wabash Twp Vol
18	West Lafayette
19	West Lafayette
20	Purdue University
21	Shadeland

ID	Hazardous Material Handler Name
0	AT&T (previously: Indiana Bell Telephone Facility)
1	ALCOA Lafayette Operations
2	Battle Ground Water Wells and Treatment
3	Battle Ground Water Wells and Treatment
4	Battle Ground Water Wells and Treatment
5	Cargill INC
6	Caterpillar, INC
7	Caterpillar Logistics-Kepner Facility
8	Caterpillar Logistics
9	Caterpillar Logistics
10	Century Tel
11	Ceres Solutions 285 (Asmark)
12	Coca Cola Bottling
13	Comcast
14	Crop Production Services 496 (previously Royster Clark)
15	Crop Production Services 455
16	Crop Production Services 420
17	Crown Castle USA
18	Bunnik Tippecanoe Labs
19	Great Lakes Chemical Corporation (a Chemtura Company)
20	Henson Cold Storage
21	Home Depot #2034
22	Ice Cream Specialties
23	Industrial Plating
24	Perry Chemical
25	Purdue University
26	Rea Magnet Wire
27	Sam's Club
28	Sunbelt Rentals #309
29	State Farm Mutual Insurance Company
30	Subaru of Indiana
31	Tate and Lyle Sagamore operations
32	Tate and Lyle Lafayette South Plant
33	Toyota Tsusho America
34	TRW Automotive
35	Verizon Lafayette NW Co
36	Frontier Communications (formerly Verizon Lafayette East)
37	Verizon Lafayette South Co
38	Verizon Lafayette Main Co
39	Verizon-Boilers
40	Verizon Lafayette East RMT
41	Verizon Creasy Lane
42	Verizon Wireless University Parking Garage
43	Wabash National South Plant
44	Wabash National
45	Waste Management
46	Westland Corp (formerly Ceres Solutions 235)

ID	School Name
0	Emella Barhart Elementary School
1	First Christian School
2	Burnnet Creek Elementary School
3	Harrison Senior High School
4	Cumberland Elementary School
5	Happy Hollow Elementary School
6	West Lafayette Junior/Senior High School
7	Vinton Elementary School
8	Oakland School
9	Miller School
10	Glenn Acres Elementary School
11	Sunnyside Junior High School
12	Murdock Elementary School
13	Jefferson High School
14	Central Catholic Junior/Senior High School
15	Cary Home for Children
16	Linnwood Elementary School
17	Miami Elementary School
18	Edgelea Elementary School
19	Lafayette Christian School
20	Tecumseh Junior High School
21	Klondike Middle School
22	Wea Ridge Elementary
23	Wea Ridge Middle School
24	Mayflower Mill Elementary School
25	McCutcheon High School
26	Dayton Elementary School
27	Wayneweight Middle School
28	Cole Elementary School
29	Battleground Middle School
30	Southwestern Junior High School
31	Mintonye Elementary School
32	Battle Ground Elementary School
33	East Tipp Junior High School
34	Hershey Elementary School
35	Battle Ground Junior High School
36	Woodland Elementary
37	Klondike Elementary School
38	St Boniface Middle School
39	St Lawrence School
40	St Mary School
41	Purdue University
42	Ivy Tech Community College
43	First Assembly Christian Academy
44	Montessori School of Greater Lafayette
45	Pleasantview Christian School
46	Washington Elementary School
47	St Lames Lutheran
48	Ivy Tech

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2014

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BASE MAP

- Cities
- RoadSegments

RAIL

- Primary Rail
- Secondary Rail
- Abandoned Rail
- Townships

N
W E
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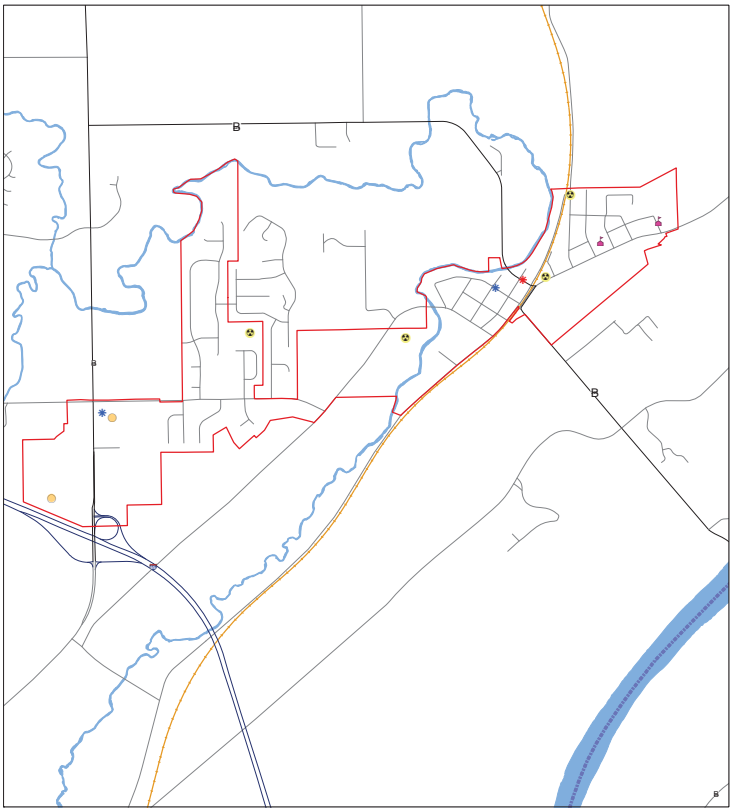
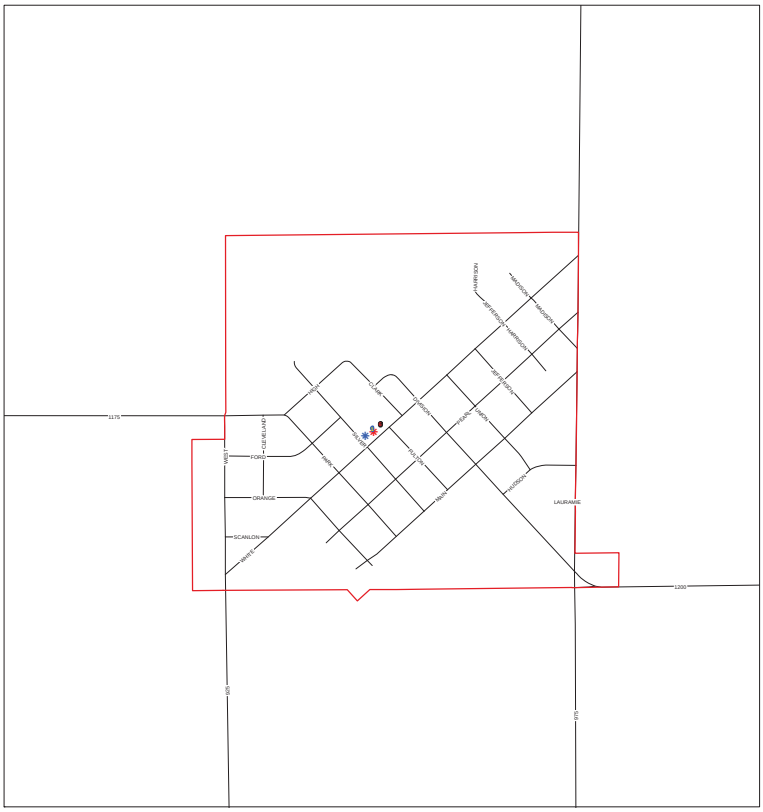
CRITICAL FACILITIES

- Airports
- Hazardous Material Handler
- Communications Tower
- Hospital
- School
- Fire Station
- Senior Living
- Police Station

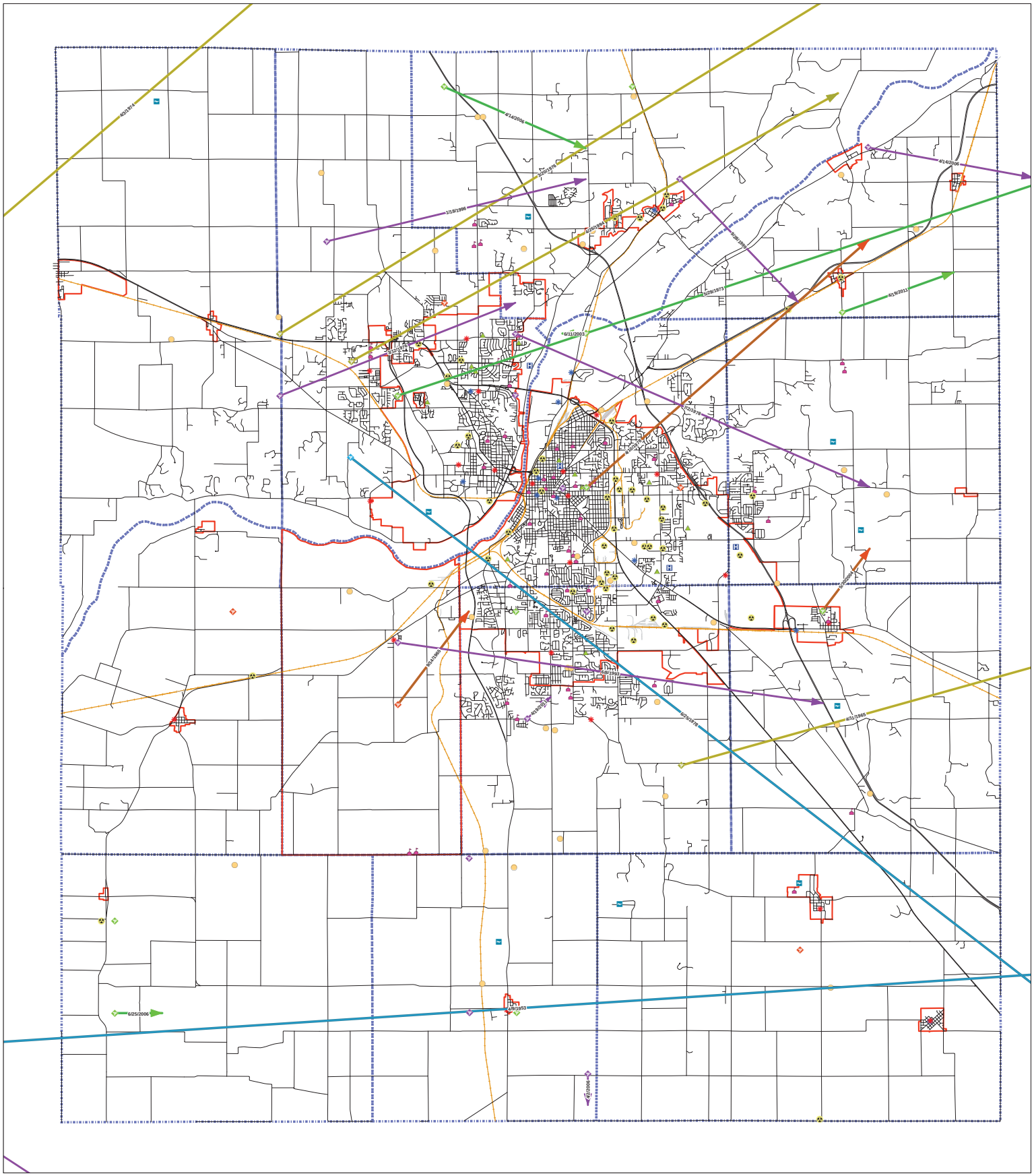
BATTLE GROUND



CLARKS HILL



HISTORICAL TORNADO ACTIVITY



BASE MAP

- RoadSegments
- Cities
- Townships

RAIL

- Primary Rail
- Secondary Rail
- Abandoned Rail

CRITICAL FACILITIES

- Airports
- Hazardous Material Handler
- Communications Tower
- Hospital
- School
- Fire Station
- Senior Living
- Police Station

TORNADOES (F SCALE)

Touchdowns	Paths
0	
1	
2	
3	
4	
5	

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Tornado information is provided by the National Weather Service Website.

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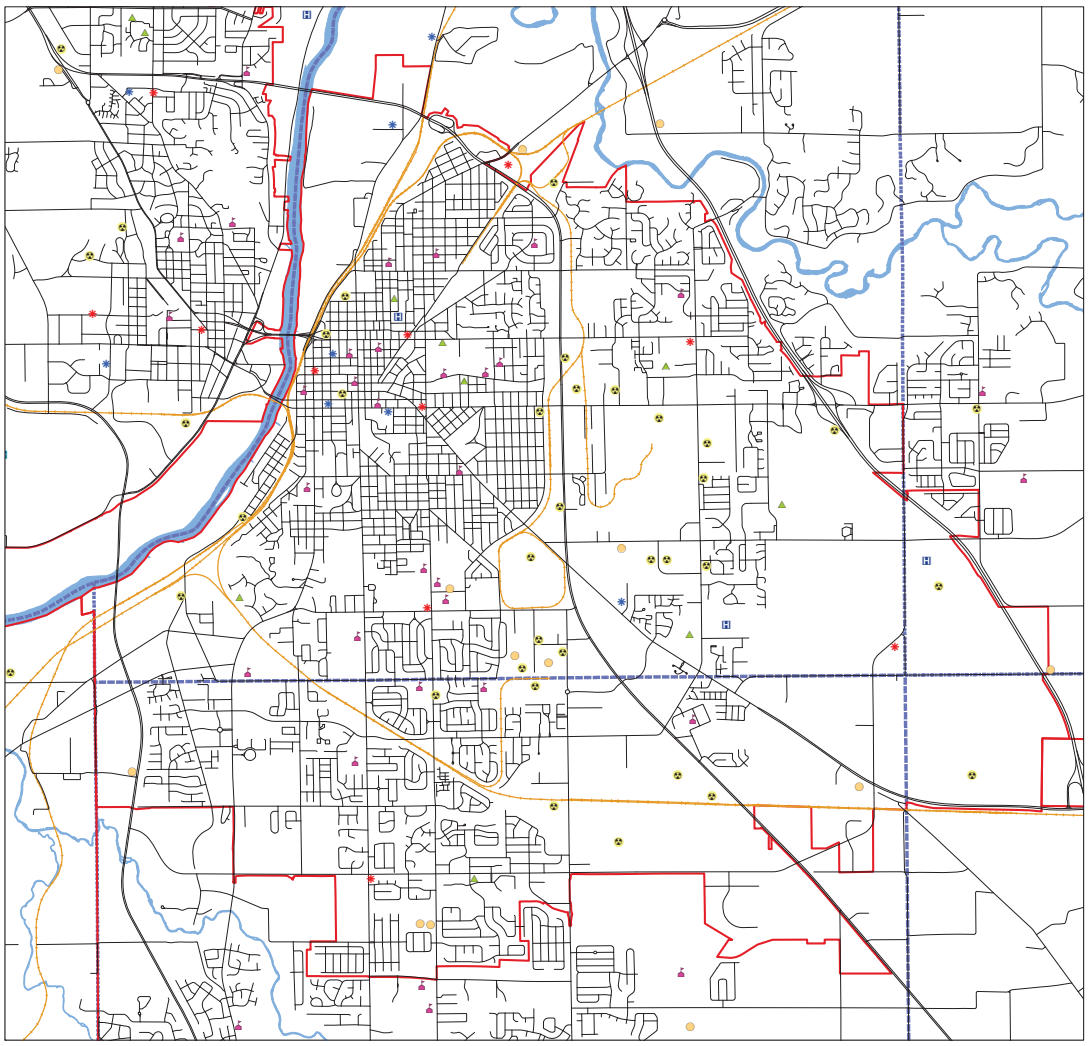
MUNICIPAL CRITICAL FACILITIES

LAFAYETTE



ID	Police Station Name
0	Dayton Town Marshal
1	Clarks Hill Town Marshal
2	Battle Ground Town Marshal
3	TBMA
4	Lafayette Police Department
5	West Lafayette Police Department
6	Purdue University Police
8	Indiana State Police Post
7	County Sheriff's Department
9	Indiana State Police Law Enforcement District 3
10	Lafayette Police

ID	Communications Tower Name
0	CELL TOWER
1	WBAA 920
2	WASK 1450
3	WLFI CH 237
4	WGLM CH 284
5	WJEF CH 220
6	WBAA-FM CH 267
7	WASK-FM CH 254
8	WKHY CH 228
9	WXKB CH 275
10	CELL TOWER
11	CELL TOWER
12	CELL TOWER
13	CELL TOWER
14	CELL TOWER

ID	Hazardous Material Handler Name
0	AT&T (previously: Indiana Bell Telephone Facility)
1	ALCOA Lafayette Operations
2	Battle Ground Water Wells and Treatment
3	Battle Ground Water Wells and Treatment
4	Battle Ground Water Wells and Treatment
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6	Caterpillar, INC
7	Caterpillar Logistics-Kepner Facility
8	Caterpillar Logistics
9	Caterpillar Logistics
10	Century Tel
11	Ceres Solutions 285 (Asmark)
12	Coca Cola Bottling
13	Comcast
14	Crop Production Services 496 (previously Royster Clark)
15	Crop Production Services 455
16	Crop Production Services 420
17	Crown Castle USA
18	Bonnik Tippecanoe Labs
19	Great Lakes Chemical Corporation (a Chemtura Company)
20	Hanson Cold Storage
21	Home Depot #0334
22	Ice Cream Specialties
23	Industrial Plating
24	Perry Chemical
25	Purdue University
26	Reo Magnet Wire
27	Sam's Club
28	Sunbelt Rentals #309
29	State Farm Mutual Insurance Company
30	Subaru of Indiana
31	Tate and Lyle Sagamore operations
32	Tate and Lyle Lafayette South Plant
33	Toyota Tsusho America
34	TRW Automotive
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36	Frontier Communications (formerly Verizon Lafayette East)
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38	Verizon Lafayette Main Co
39	Verizon-Boilers
40	Verizon Lafayette East RMT
41	Verizon Creasy Lane
42	Verizon Wireless University Parking Garage
43	Wabash National South Plant
44	Wabash National
45	Waste Management
46	Westland Corp (formerly Ceres Solutions 235)

ID	School Name
0	Amelia Earhart Elementary School
1	First Christian School
2	Burnett Creek Elementary School
3	Harrison Senior High School
4	Cumberland Elementary School
5	Happy Hollow Elementary School
6	West Lafayette Junior/Senior High School
7	Vinton Elementary School
8	Oakland School
9	Miller School
10	Glenn Acres Elementary School
11	Sunnyside Junior High School
12	Murdock Elementary School
13	Jefferson High School
14	Central Catholic Junior/Senior High School
15	Cary Home for Children
16	Linne ood Elementary School
17	Miami Elementary School
18	Bilgelles Elementary School
19	Lafayette Christian School
20	Tecumseh Junior High School
21	Klondike Middle School
22	Wea Ridge Elementary
23	Wea Ridge Middle School
24	Mayflower Mill Elementary School
25	McCutcheon High School
26	Dayton Elementary School
27	Wayneright Middle School
28	Colle Elementary School
29	Battleground Middle School
30	Southwestern Junior High School
31	Mintonye Elementary School
32	Battle Ground Elementary School
33	East Tipp Junior High School
34	Hershey Elementary School
35	Battle Ground Junior High School
36	Woodland Elementary
37	Klondike Elementary School
38	St Boniface Middle School
39	St Lawrence School
40	St Mary School
41	Purdue University
42	Ivy Tech Community College
43	First Assembly Christian Academy
44	Montessori School of Greater Lafayette
45	Pleasantview Christian School
46	Washington Elementary School
47	St James Lutheran
48	Ivy Tech
49	Wyandotte Elementary School

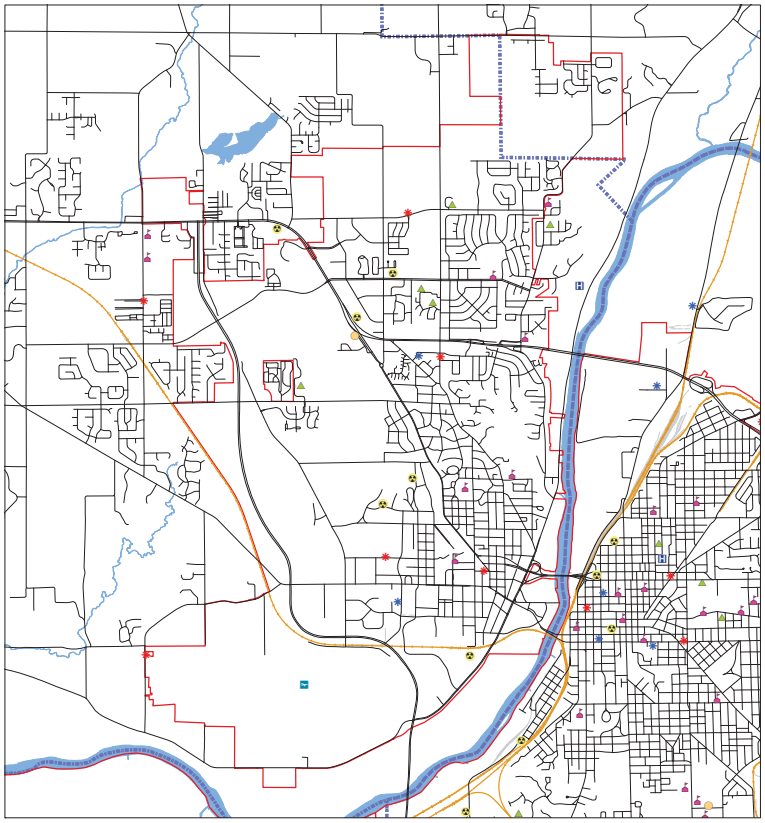
ID	Hospital Name
0	St. Elizabeth Central Hospital
1	IuClarian Hospital
2	Riverside Hospital

ID	Nursing Home Name
0	Heritage Healthcare Nursing Facility
1	Greentree at West Lafayette
2	George Davis Manor
3	Indiana Developmental Training Center
4	Regency Place of Lafayette
5	Roseveilt Village
6	Saint Anthony Healthcare
7	Saint Mary Healthcare Center
8	University Place
9	Bickford Assisted Living
10	Westminster Village
11	Creasy Springs
12	Sycamore Springs

ID	Fire Station Names
0	Buck Creek
1	Randolph Twp
2	Wea Twp Community
3	West Point
4	Sheffield Twp
5	Tippecanoe Twp Vol
6	Clarks Hill Vol
7	Lauramie Twp Vol
8	City of Lafayette 1
9	City of Lafayette 2
10	City of Lafayette 3
11	City of Lafayette 5
12	City of Lafayette 6
13	City of Lafayette 7
14	City of Lafayette 8
15	City of Lafayette 9
16	Wabash Twp Vol
17	Wabash Twp Vol
18	West Lafayette
19	West Lafayette
20	Purdue University
21	Shadeland

ID	Airport Name
0	WILDCAT AIR LANDING AREA
1	PURDUE UNIVERSITY
2	TIMBER HOUSE
3	MYANDOTTE
4	ETTER
5	RATCLEF
6	SUTTON
7	FELIX
8	DAVINE

WEST LFAYETTE



BASE MAP

- RoadSegments
- Cities
- Townships
- RailRoad

CRITICAL FACILITIES

- Airports
- Hazardous Material Handler
- Communications Tower
- Hospital
- School
- Fire Station
- Senior Living
- Police Station

The Area Plan Commission of Tippecanoe County

2014

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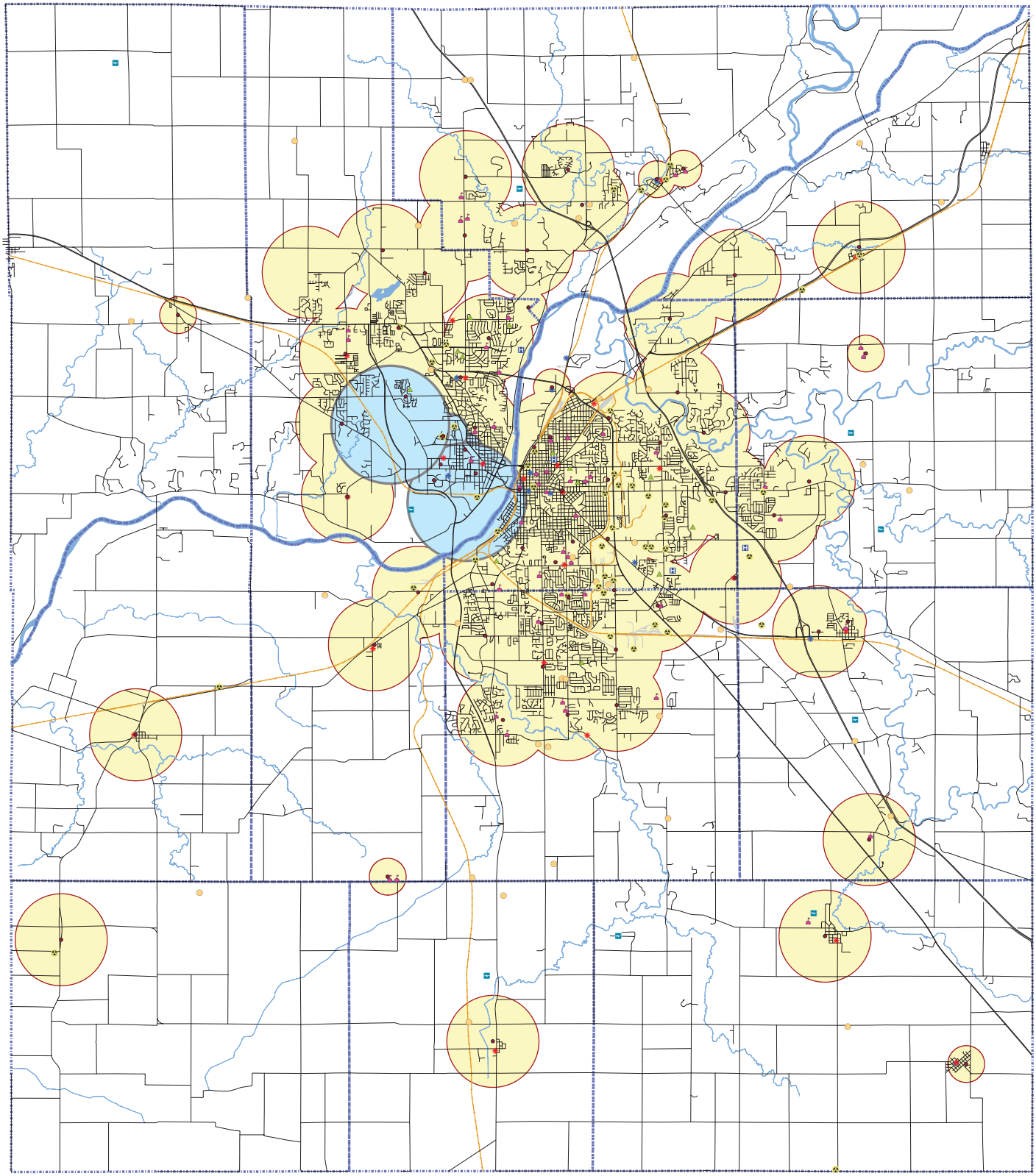
Warning Sirens



BASE MAP

- RoadSegments
- Cities
- Townships

RAIL

- Primary Rail
- Secondary Rail
- Abandoned Rail

CRITICAL FACILITIES

- Airports
- Hazardous Material Handler
- Communications Tower
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- School
- Fire Station
- Senior Living
- Police Station

WARNING SIRENS

- 2012 New Siren Coverage Areas
- Warning Siren Coverage

The Area Plan Commission of Tippecanoe County

2014

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Siren data provided by
Tippecanoe County Emergency Managment Agency

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