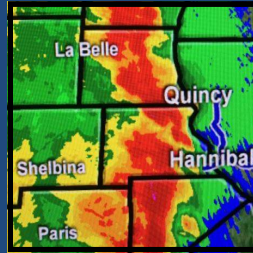


# MARION COUNTY, MISSOURI HAZARD MITIGATION PLAN 2016–2021



**CONTRIBUTORS****Marion County Hazard Mitigation Planning Committee****Jurisdictional Representatives**

<b>Name</b>	<b>Title</b>	<b>Department</b>	<b>Jurisdiction/Agency/Organiz</b>
John Hark	County Emergency Manager	Emergency	County of Marion
Eric Church	Superintendent	Administration	Palmyra R-1 School
John Lewis	City EMD	Emergency	City of Palmyra
Lori Perry	Director of Security	Administration	MACC
Jeff LaGarce	City Manager	Administration	City of Hannibal
Teya Stice	County Coordinator	Administration	County of Marion
Angelica Vance	City Clerk	Administration	City of Hannibal
Kyle Brennemann	Chief Public Safety Officer	Administration	Hannibal LaGrange University

**Stakeholder Representatives**

<b>Name</b>	<b>Title</b>	<b>Department</b>	<b>Agency/Organization</b>
Rich Donelson	CEO	Administration	Missouri REC
Sue Bridgman	Finance Manager	Administration	Missouri REC
Jeff Funkenbush	Administrator	Administration	Maple Lawn Nursing Home
John Zerbonia	LT	Public Safety	City of Hannibal
John Nemes	Chief	Public Safety	Marion County Ambulance
Mike Hall	Director	Public Safety	Marion County 911
Sean Hampton	Fire Chief	Public Safety	City of Hannibal
Ruth Ann Wright	Assistant to Coordinator	Administration	County of Marion
Brian Chaplin	Superintendent	Public Works	City of Hannibal - BPW
Doug Ruble	VP of Facilities	Administration	Hannibal Regional Hospital
Brent Hoerr	President		Marion Co. Drainage District
Roger Sutter	President		Fabius River Drainage District
Mike Schaefer	Administrator		Marion County Highway Dept.
Gary Crane	Fire Chief	Public Safety	Palmyra Fire Department
Jimmy Shinn	Sheriff	Public Safety	Marion County
David Bleigh	President		South River Drainage District
Paula Gough	District Engineer	Highway	MoDOT
Mary Culler	Coordinator	Environmental Quality	MO DNR

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## EXECUTIVE SUMMARY

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The purpose of hazard mitigation is to reduce or eliminate long-term risk to people and property from hazards. Marion County and participating jurisdictions and school/special districts developed this multi-jurisdictional local hazard mitigation plan update to reduce future losses from hazard events to the Marion County and its communities and school/special districts. The plan is an update of a plan that was approved on June 23, 2011. The plan and the update were prepared pursuant to the requirements of the Disaster Mitigation Act of 2000 to result in eligibility for the Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance Grant Programs.

The County Multi-Hazard Mitigation Plan is a multi-jurisdictional plan that covers the following 3 jurisdictions that participated in the planning process:

Unincorporated Marion County                      City of Hannibal  
Palmyra Public School District

The Hannibal Public School District, Marion County C-3, Moberly Area Community College and Hannibal LaGrange University were invited to participate in the planning process, but did not meet all of the established requirements for official participation. When the future five-year update is developed for this plan, these school districts and higher levels of education will be invited again to participate. The City of Palmyra participated in the Kick-Off meeting but did not provide the Data Collection Questionnaire nor update and identify Action Items.

Marion County and the entities listed above developed a Multi-Jurisdictional Hazard Mitigation Plan that was approved by FEMA on June 23, 2011 (hereafter referred to as the *2011 Hazard Mitigation Plan*). This current planning effort serves to update that previously approved plan.

The plan update process followed a methodology prescribed by FEMA, which began with the formation of a Mitigation Planning Committee (MPC) comprised of representatives from Marion County and participating jurisdictions. The MPC updated the risk assessment that identified and profiled hazards that pose a risk to Marion County and analyzed jurisdictional vulnerability to these hazards. The MPC also examined the capabilities in place to mitigate the hazard damages, with emphasis on changes that have occurred since the previously approved plan was adopted. The MPC determined that the planning area is vulnerable to several hazards that are identified, profiled, and analyzed in this plan. Riverine and flash flooding, winter storms, severe thunderstorms/hail/lightning/high winds, and tornadoes are among the hazards that historically have had a significant impact.

Based upon the risk assessment, the MPC updated goals for reducing risk from hazards. The goals are listed below:

1. Protect the lives and livelihood of all the citizens.
2. Decrease the impact of natural hazards.
3. Ensure continued operation of government and emergency function in a disaster.

To advance the identified goals, the MPC developed recommended mitigation actions, which are detailed in Chapter 4 of this plan. The MPC developed an implementation plan for each action, which identifies priority level, background information, ideas for implementation, responsible agency, timeline, cost estimate, potential funding sources, and more.



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## PREREQUISITES

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**44 CFR requirement 201.6(c)(5): The local hazard mitigation plan shall include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan. For multi-jurisdictional plans, each jurisdiction requesting approval of the plan must document that it has been formally adopted.**

This plan has been reviewed by and adopted with resolutions or other documentation of adoption by the following participating jurisdictions and schools/special districts. The documentation of each adoption is included in Appendix D, and a model resolution is included on the following page.

The following jurisdictions participated in the development of this plan and have adopted the multi-jurisdictional plan.

- Unincorporated Marion County
- City of Hannibal
- Palmyra School District

**Model Resolution**

Resolution # \_\_\_\_\_

**Adopting the Marion County Multi-Jurisdictional Local Hazard Mitigation Plan**

**Whereas**, the (Name of Government/District/Organization seeking FEMA approval of hazard mitigation plan) recognizes the threat that natural hazards pose to people and property within our community; and

**Whereas**, undertaking hazard mitigation actions will reduce the potential for harm to people and property from future hazard occurrences; and

**Whereas**, the U.S. Congress passed the Disaster Mitigation Act of 2000 (“Disaster Mitigation Act”) emphasizing the need for pre-disaster mitigation of potential hazards;

**Whereas**, the Disaster Mitigation Act made available hazard mitigation grants to state and local governments; and

**Whereas**, an adopted Local Hazard Mitigation Plan is required as a condition of future funding for mitigation projects under multiple FEMA pre- and post-disaster mitigation grant programs; and

**Whereas**, the (Name of Government/District/Organization) fully participated in the hazard mitigation planning process to prepare this Multi-Jurisdictional Local Hazard Mitigation Plan; and

**Whereas**, the Missouri State Emergency Management Agency and the Federal Emergency Management Agency Region VII officials will review the “Marion County Multi-Jurisdictional Local Hazard Mitigation Plan,” and approved it as to form and content; and

**Whereas**, the (Name of Government/District/Organization) desires to comply with the requirements of the Disaster Mitigation Act and to augment its emergency planning efforts by formally adopting the Marion County Multi-Jurisdictional Local Hazard Mitigation Plan; and

**Whereas**, adoption by the governing body for the (Name of Government/District/Organization) demonstrates the jurisdictions’ commitment to fulfilling the mitigation goals outlined in this Multi-Jurisdictional Local Hazard Mitigation Plan; and

**Whereas**, adoption of this legitimizes the plan and authorizes responsible agencies to carry out responsibilities under the plan;

**Now, therefore, be it resolved**, that the (Name of Government/District/Organization) has adopted the “Marion County Multi-Jurisdictional Local Hazard Mitigation Plan” as an official plan.

Date: \_\_\_\_\_

Certifying Official: \_\_\_\_\_

# 1 INTRODUCTION AND PLANNING PROCESS

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## 1.1 Purpose

Hazard mitigation is “any action taken to reduce or eliminate the long-term risk to human life and property from natural hazards”. We understand that hazard events will continue to occur, and at their worst can result in death and destruction of property and infrastructure. The work done to minimize the impact of hazard events to life and property is called hazard mitigation. Marion County and the participating jurisdictions and school districts developed this multi-jurisdictional local hazard mitigation plan update to reduce future losses from hazards.

- The County of Marion, City of Hannibal and the Palmyra R-1 School District adopted the Plan as a prerequisite for mitigation grant eligibility pursuant to the Disaster Mitigation Act of 2000 (Public Law 106-390) and the implementing regulations set forth by the Interim Final Rule published in the *Federal Register* on February 26, 2002, (44 CFR §201.6) and finalized on October 31, 2007. (Hereafter, these requirements and regulations will be referred to collectively as the Disaster Mitigation Act or DMA). The regulations established the requirements for local hazard mitigation plans are in the Robert T. Stafford Disaster Relief and Emergency Act (Public Law 93-288).
- The schools of Marion County C-3, Hannibal Public Schools, Moberly Area Community College and Hannibal La-Grange University will not be eligible for grant funding due to their lack of participation and plan adoption nor will the City of Palmyra.

## 1.2 Background and Scope

This plan is a 5-year update of a plan that was approved on June 23, 2011. The plan and update were prepared pursuant to the requirements of the Disaster Mitigation Act of 2000 to result in the eligibility for the Federal Emergency Management Agency (FEMA) hazard Mitigation Assistance Grant programs.

- Following is a list of participants in both the previous plan as well as the current update:  

County of Marion	City of Hannibal	City of Palmyra*
Palmyra School District	Moberly Area Community College*	

Hannibal La-Grange University as well as Marion County C-3 school district participated in the prior plan, but chose not to participate in the this plan update.

\*Moberly Area Community College has a satellite campus in Hannibal thus were included in the planning process and had a representative at meetings. They will not be adopting the Marion County plan but rather may choose to be a more active participant in the update of the Randolph County plan. The City of Palmyra participated in the first planning meeting, but did not provide data for the plan. The Plan may be amended at a later date to include the City.

A very small section of Monroe City is located in Marion County. They will be actively participating in the Monroe County plan and chose not to be engaged in the Marion County plan.

In addition to securing grant funding eligibility, the plan is useful for incorporating hazard mitigation planning and principals into other documents, such as zoning regulations and land use plans.

## 1.3 Plan Organization

The current update document involved review, evaluation and amendment of the existing Plan. It addresses the same natural hazards that were addressed in the original Plan.

Following is a breakdown of the organization of the 2016 Marion County Hazard Mitigation Plan update.

- Chapter 1: Introduction and Planning Process
- Chapter 2: Planning Area Profile and Capabilities
- Chapter 3: Risk Assessment
- Chapter 4: Mitigation Strategy
- Chapter 5: Plan Implementation and Maintenance
- Appendices

### Table 1.1. Changes Made in Plan Update

In **Section 1:** The history of the original plan and the process of updating it were outlined as well as participating entities.

In **Section 2:** (Profile and Capabilities) All Census and economic demographic data was updated.

In **Section 3:** (Risk Assessment) All Hazard Event Data was updated and new risk and vulnerability analysis were performed using new data.

In **Section 4:** A large number of actions were discarded from the previous plan and can be found on Table 4.1. One new action item was added that being from the Palmyra R-I School District to construct a FEMA approved safe room.

In **Section 5:** (Plan Maintenance) The plan maintenance process was revamped and detailed to include annual and spontaneous plan review meetings.



## 1.4 Planning Process

**44 CFR Requirement 201.6(c)(1): [The plan shall document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.**

Marion County, Missouri contracted with the Mark Twain Regional Council of Governments (COG) to facilitate the update of the multi-jurisdictional, local hazard mitigation plan. In fulfillment of this role, the COG:

- Assisted in establishing a Mitigation Planning Committee (MPC) as defined by the Disaster Mitigation Act (DMA),
- Ensured the updated plan met the DMA requirements as established by federal regulations and followed the most current planning guidance of the Federal Emergency Management Agency (FEMA),
- Facilitated the entire plan development process,
- Identified the data that MPC participants could provide and conducted the research and documentation necessary to augment that data,
- Assisted in soliciting public input,
- Produced the draft and final plan update in a FEMA-approvable document, and Coordinate the Missouri State Emergency Management Agency (SEMA) and (FEMA) plan reviews.

**Table 1.2. Jurisdictional Representatives Marion Co. Mitigation Planning Committee**

Name	Title	Department	Jurisdiction/Agency /Organization
Teya Stice (A)	County Coordinator	County Govt.	Marion County
Jeff LaGarce (A)	City Manager	City Govt.	City of Hannibal
John Lewis (I)	EMD	City Govt.	City of Palmyra
Angelica Vance (A)	City Clerk	City Govt.	City of Hannibal
John Hark (A)	EMD	City/County Govt.	City of Hannibal/Marion Co.
Eric Churchwell (A)	Superintendent	Schools	Palmyra R-1
Rich Donelson (I)	CEO	Utilities	MO REC
Sue Bridgman (I)	Finance Manager	Utilities	MO REC
Lori Perry (I)	Director of Security	Schools	Moberly Area Com. College
Jeff Funkenbusch (I)	Administrator	Nursing Home	Maple Lawn Nursing Home
John Zerbonia (I)	Lieutenant	Public Safety	Hannibal PD
John Nemes (I)	Chief	Public Safety	Marion County Ambulance
Mike Hall (I)	Director	Public Safety	Marion County 911
Sean Hampton (I)	Chief	Public Safety	Hannibal Fire Department

Brian Chaplin (I)	Superintendent	Utilities	Hannibal BPW
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Active representatives are indicated by (A) and were responsible for providing data, setting priorities and evaluating action items for the plan. Inactive members assisted active representatives in gathering information, setting priorities and goal setting. Inactive members were apprised of all meetings and encouraged to attend and participate.

### 1.4.1 Multi-Jurisdictional Participation

**44 CFR Requirement §201.6(a)(3): Multi-jurisdictional plans may be accepted, as appropriate, as long as each jurisdiction has participated in the process and has officially adopted the plan.**

Hazard mitigation is defined as “sustained action take to reduce or eliminate the long-term risk to human life and property from hazards” and its purpose is to lessen the negative impact of a disaster on community’s economic, social and environmental well-being.

Outreach programs that increase the public’s awareness of hazard risks, projects to protect critical facilities and the removal of structures from flood hazard areas are all examples of mitigation actions. Local mitigation actions and concepts can also be incorporated into land use plans and building codes.

Local governments have the responsibility to protect the health, safety and welfare of their citizens. Proactive mitigation policies and actions help reduce risk and create safer, more disaster-resilient communities. Mitigation is an investment in a community’s future safety and sustainability by facilitating:

- The protection of public safety and prevention of loss of life and injury
- The reduction of harm to existing and future development
- The prevention of damage to a community’s unique assets

The importance of active public participation in such an endeavor is obvious, but can be difficult to obtain in reality. Nowhere is difficulty more apparent than in small rural communities like those in Northeast Missouri. The City of Hannibal participated in all elements of the planning process, however the City of Palmyra had a representative at the first meeting but did not choose to complete the Data Collection Questionnaire or submit Action Items. Some of the schools chose to opt out due to their perception of lack of benefit.

Local government jurisdictions and school districts were invited to participate in the planning process via email and in many cases follow up phone calls and personal contact (Appendix A – public participation documentation). Committee members were placed on a contact list featuring email and contact information. They were also directed to the COG webpage.

Jurisdictions that are presented by a multi-jurisdictional plan are required to participate in the planning process and formally adopt the plan. The County of Marion, City of Hannibal and the Palmyra R-1 School District participated in the plan update by meeting minimal requirements as described in the next paragraph. Each participating jurisdiction will formally adopt the mitigation plan.

Minimum participation requirements included:

- Designation of a representative to serve on the MPC
- Provision of sufficient information to support the plan development by completing and returning the Data Collection Questionnaires and validating/correcting critical facility inventories
- When applicable provide progress on mitigation actions from the previously approved plan and identify additional mitigation actions for the plan
- Review and comment on plan drafts
- Provision of documentation to show time donated to the planning effort
- Formal adoption of the mitigation plan prior to submittal to SEMA and FEMA for final approval.

Provide a table (**Table 1.3**) showing the representation of each participating jurisdiction at the planning meetings, the provision of responses to the Data Collection Questionnaire, the active critical facility validation, the update/development of mitigation actions, and the documentation of donated time. Reference sign-in sheets and other documentation located in an appendix.

**Table 1.3. Jurisdictional Participation in Planning Process**

Jurisdiction	Kick-off Meeting & Meeting 2 combined	Meeting #3	Data Collection Questionnaire Response	Update/Develop Mitigation Actions
City of Palmyra	X	No	No	No
City of Hannibal	X		X	X
County of Marion	X		X	X
Palmyra Public School	X		X	X
MACC	X	No	No	No
Hannibal LaGrange College	No	No	No	No
Marion County R-II	No	No	No	No

### 1.4.2 The Planning Steps

**Table 1.4. Marion County Mitigation Plan Update Process**

Community Rating System (CRS) Planning Steps (Activity 510)	Local Mitigation Planning Handbook Tasks (44 CFR Part 201)
Step 1. Organize	Task 1: Determine the Planning Area and Resources
	Task 2: Build the Planning Team 44 CFR 201.6(c)(1)
Step 2. Involve the public	Task 3: Create an Outreach Strategy 44 CFR 201.6(b)(1)
Step 3. Coordinate	Task 4: Review Community Capabilities 44 CFR 201.6(b)(2) & (3)
Step 4. Assess the hazard	Task 5: Conduct a Risk Assessment 44 CFR 201.6(c)(2)(i) 44 CFR 201.6(c)(2)(ii) & (iii)
Step 5. Assess the problem	
Step 6. Set goals	Task 6: Develop a Mitigation Strategy 44 CFR 201.6(c)(3)(i); 44 CFR 201.6(c)(3)(ii); and 44 CFR
Step 7. Review possible activities	

Step 8. Draft an action plan	201.6(c)(3)(iii)
Step 9. Adopt the plan	Task 8: Review and Adopt the Plan
Step 10. Implement, evaluate, revise	Task 7: Keep the Plan Current
	Task 9: Create a Safe and Resilient Community 44 CFR 201.6(c)(4)

The initial scoping process of the planning effort consisted of soliciting local jurisdictions for a representative to attend the kick-off meeting and ultimately participate in the planning process. This was conducted during September, 2015 and consisted of face to face meetings with representatives from local jurisdictions, telephone conversations as well as e-mail correspondence. Information shared included explanation of the planning process and the importance of jurisdictional participation.

In the essence of time, the kick-off meeting and meeting number 2 were combined. This meeting was held on January 6, 2016 (Appendix A) at the Marion County 991 office in Hannibal. The meeting lasted approximately 2 hours. Representatives from various REC's, the Palmyra School District, Cities of Palmyra and Hannibal, County of Marion, Marion County ambulance, Marion County 911, Hannibal Police Department, Maple Lawn Nursing Home, Moberly Area Community College, Hannibal Fire Department, and Hannibal Board of Public Works were in attendance. The agenda encompassed the purpose of the plan, grant programs linked to the approved plan, determining the planning area, building the team and stakeholders, participation requirements, public outreach, data collection questionnaires, discussion of hazards, the risk assessment, determining and updating the goals, future actions and next meeting date. Minutes from the meeting area incorporated into the plan in Appendix A.

Following this meeting, staff of the COG reached out to absent potential planning team members and provided them with an update of the meeting as well as the data collection questionnaire via e-mail and subsequent phone calls. The importance of participating in the planning effort was stressed repeatedly.

### ***Step 1: Organize the Planning Team (Handbook Tasks 1 & 2)***

In late August, September and November, 2015 staff from the COG met with identified participants from the Cities of Hannibal and Palmyra, the Marion County Coordinator and EMD. The initial "scoping" meetings potential mitigation planning committee members were discussed and identified, dates for possible meetings and a general overview of the plan update process. Minutes are incorporated into Appendix A. In addition to face to face meetings, numerous follow up phone calls were made to discuss the process, obtain contact information, establish a data base and answer questions.

In the interest of time, the Kick Off meeting and Meeting 2 were combined on January 6, 2016 at 1:30 p.m. at the Marion County 911 office. The agenda for this meeting is included in Appendix A which describes the topics of discussion, minutes and a signature sheet.

**Table 1.5. Schedule of MPC Meetings**

Meeting	Topic	Date
Informational Meeting	Met directly with local jurisdictions and follow up phone calls to discuss the planning process and importance of participation	August- December, 2015
Kick-off Meeting & Meeting 2	Purpose, process, planning area, building the team and stakeholders, participation requirements, public outreach, data collection questionnaires, discussion of hazards, risk assessment, determine/update goals, actions and next meeting.	January 6, 2016 Marion County 911 office
Planning Meeting #3	Review of the draft plan, discussion of plan update process, plan maintenance, discussion of adoption resolutions. Submission to SEMA/FEMA	September 26, 2016

Each meeting was advertised at least one week in advance with local jurisdictions encouraged to share the information.

### ***Step 2: Plan for Public Involvement (Handbook Task 3)***

**44 CFR Requirement 201.6(b): An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.**

In the interest of time, the Kick Off meeting and Meeting 2 were combined on January 6, 2016 at 1:30 p.m. at the Marion County 911 office. The agenda for this meeting is included in Appendix A which describes the topics of discussion, minutes, signature sheet and copies of the handouts. As seen in the minutes, the participants felt a survey tool would not be effective and chose to solicit public involvement at the local level as they would be the key contacts for obtaining public comment. A press release inviting the public to participate in the plan update was sent to the Hannibal Courier Post, the Palmyra Spectator and provided to the Marion County Coordinator to post on December 30, 2015 (copies in Appendix A). Public notices were also provided to the Cities of Hannibal and Palmyra to post in prominent locations to encourage public involvement.

A subsequent public notice was posted in the County Courthouse and City Halls on January 7, 2016 inviting additional public input regarding the update. (*Public Input Accepted for Marion County Hazard Mitigation Plan*). Comments were invited until March 1, 2016. See Appendix A.

On September 9, 2016, a Press Release was issued informing the public of the opportunity to review and comment on the plan prior to its finalization. The Press Release was sent to the Hannibal Courier Post, Palmyra Spectator and also posted on the COG website and Facebook page. The Press Release was also sent to the Cities of Palmyra and Hannibal and the Marion County Coordinator to post in a prominent location. A copy is included in Appendix A.



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No public comments were received which is characteristic for the area. The public in Marion County typically does not become active in planning activities such as plan development or updates.

***Step 3: Coordinate with Other Departments and Agencies and Incorporate Existing Information (Handbook Task 3)***

**44 CFR Requirement 201.6(b): An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process. (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.**

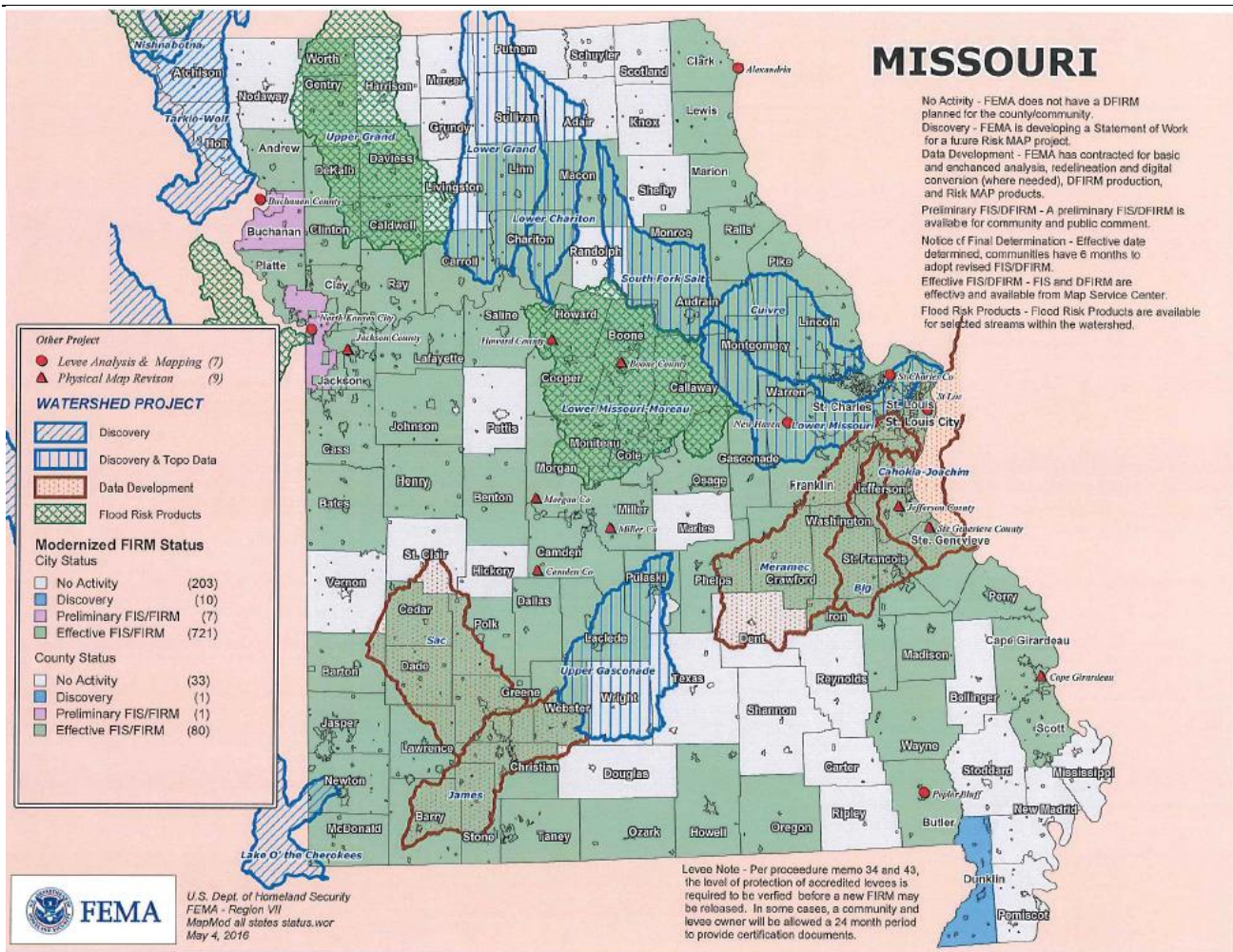
Stakeholders such as levee districts, public safety, hospital, RECs, Board of Public Works, MoDOT and MO DNR were included in the planning process (January 6, 2016 meeting) and given an opportunity to comment on the draft plan. They were also invited to attend Meeting #3. See Appendix A.

**Coordination with FEMA Risk MAP Project**

Below is information regarding Risk Map activities in Marion County. Representatives of the South River Drainage District were invited to participate in the planning process however did not.

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**Figure 1.1. Map of Risk MAP projects**



**Risk MAP Progress Project Details**

Region	State	County Name	County FIPS	Project Type	Project Status	Watershed Name	Watershed HUC ID	FY First Funded	Preliminary Map	Effective Map	Case Number	Project Name	Community Name	Community ID
7	Missouri	Marion	29127	LEVEE	Active			FY10	FY15	07/20/2016	11-07-0674S	Marion CO, MO South River DD Levee PMR (FY11/10)	MARION COUNTY *	290222
7	Missouri	Marion	29127	LEVEE	Active			FY10	FY15	07/20/2016	11-07-0674S	Marion CO, MO South River DD Levee PMR (FY11/10)	MARION COUNTY *	290222
7	Missouri	Marion	29127	WATERSHED	Completed	South Fork Salt	07110006	FY11			12-07-0371S	South Fork Salt HUC 07110006 FY 11 (O-W) REG	MONROE CITY, CITY OF	290688

Data as of: 07/12/2016

**Integration of Other Data, Reports, Studies, and Plans**

Other documents critical to the formation of the plan included the Marion County FIS, FIRMS, Data from MO DNR regarding watershed activities, MO DNR dam information, National Inventory of Dams, Census data, information provided by the US Department of Agriculture, Bureau of Labor Statistics and State of Missouri Hazard Mitigation Plan.

***Step 4: Assess the Hazard: Identify and Profile Hazards (Handbook Task 5)***

At the January 6, 2016 meeting the MPC and profiled their hazards which was accomplished by reviewing:

- previous disaster declarations in the county
- hazards in the most recent State Hazard Mitigation Plan
- hazards identified in the previously approved hazard mitigation plan.

The results of this process can be reviewed in Section 4 of this document. Data Collection Questionnaires from the previous plan update were disseminated to jurisdictions in attendance. Participants were requested to review and update the Questionnaires to the COG no later than January 22, 2016. An email to those not in attendance but considered potential planning team members was sent requesting completion of the Data Collection Questionnaire.

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**Step 5: Assess the Problem: Identify Assets and Estimate Losses**

Assets were identified with demographic data from the US Census, Census of Agriculture, GIS structure data and the Data Collection Questionnaires.

Loss estimates could not be provided due to lack of information provided by participating jurisdictions. MPC members could not ascertain the value of buildings in the community, thus the information was not provided.

**Step 6: Set Goals (Handbook Task 6)**

The MPC reviewed the goals from the previously approved plan at the January 6, 2016 meeting and accepted those with no changes. They include:

1. Protect the lives and livelihood of all the citizens.
2. Decrease the impact of natural hazards.
3. Ensure continued operation of government and emergency function in a disaster.

**Step 7: Review Possible Mitigation Actions and Activities**

As part of January 6, 2016 meeting, members were asked to review the mitigation strategy from the previously approved plan and note changes and update as it pertains to their individual jurisdictions. Committee members were requested to address progress (or lack thereof) on previously identified actions in the previously approved plan. MPC members were encouraged to continue forward only those actions that substantively address long-term mitigation solutions to the risks identified in the risk assessment.

There were virtually no changes to any of the risks assessed in the plan. The MPC used the STAPLEE method to analyze and prioritize proposed actions. Members were provided a copy of the FEMA publication *Mitigation Ideas – A Resource for Reducing Risk to Natural Hazards*.

**Step 8: Draft an Action Plan**

Proposed actions were provided by MPC members and rated using the STAPLEE methodology. These actions were reviewed for concurrence by the MPC on September 26, 2016 during final review of the draft plan.

**Step 9: Adopt the Plan (Handbook Task 8)**

After the draft plan was composed, adoption resolutions examples were given to the jurisdictional representatives at the meeting to return to their respective governing bodies for adoption by whatever means their jurisdictions utilize for such activities.

**Step 10: Implement, Evaluate, and Revise the Plan (Handbook Tasks 7 & 9)**

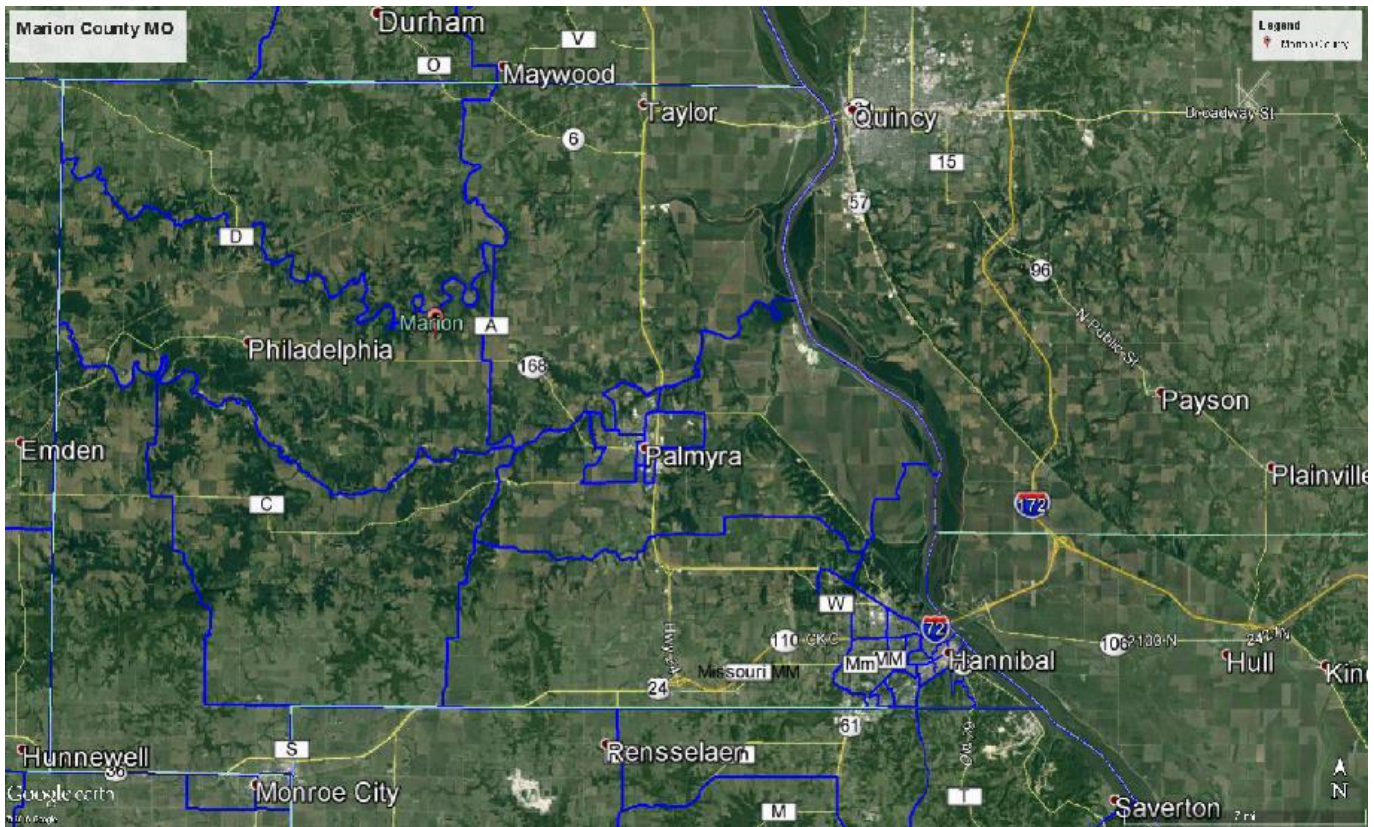
Part of the plan draft development included an outline of plan maintenance (Chapter 5) and was discussed and accepted by the MPC at the September 26, 2016 planning meeting. This process includes reviews annually and in the wake of any significant hazard event, as well as provisions for the five-year update process.

## 2 PLANNING AREA PROFILE AND CAPABILITIES

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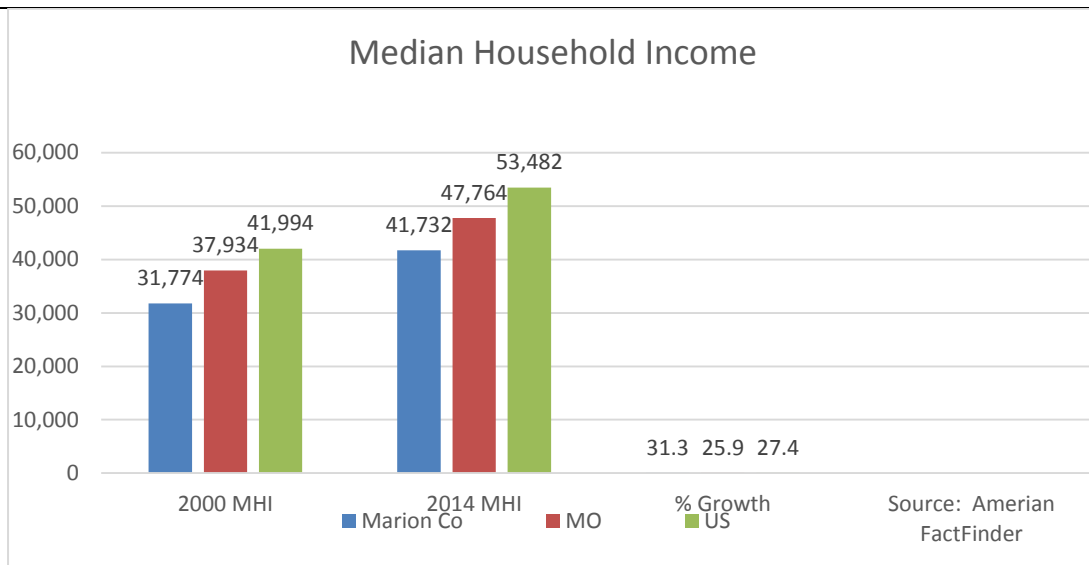
## 2.1 Marion County Planning Area Profile





**Figure 2.1 Map of Marion County**

According to the US Census, the population estimate for Marion County of July 1, 2015 is 28,880 persons compared to the 2010 Census population of 28,781; a modest .3% growth estimate in the five year period. This percent of growth falls far behind the growth estimate for the State of Missouri for the same time period (1.6%) and of the Nation at 4.1%. According to the 2015 population estimates, Marion County has experienced 2.1% increase in population since the 2000 Census. Below is a graph depicting changes in median household incomes within the County, State and Nation for 2010 and 2014.



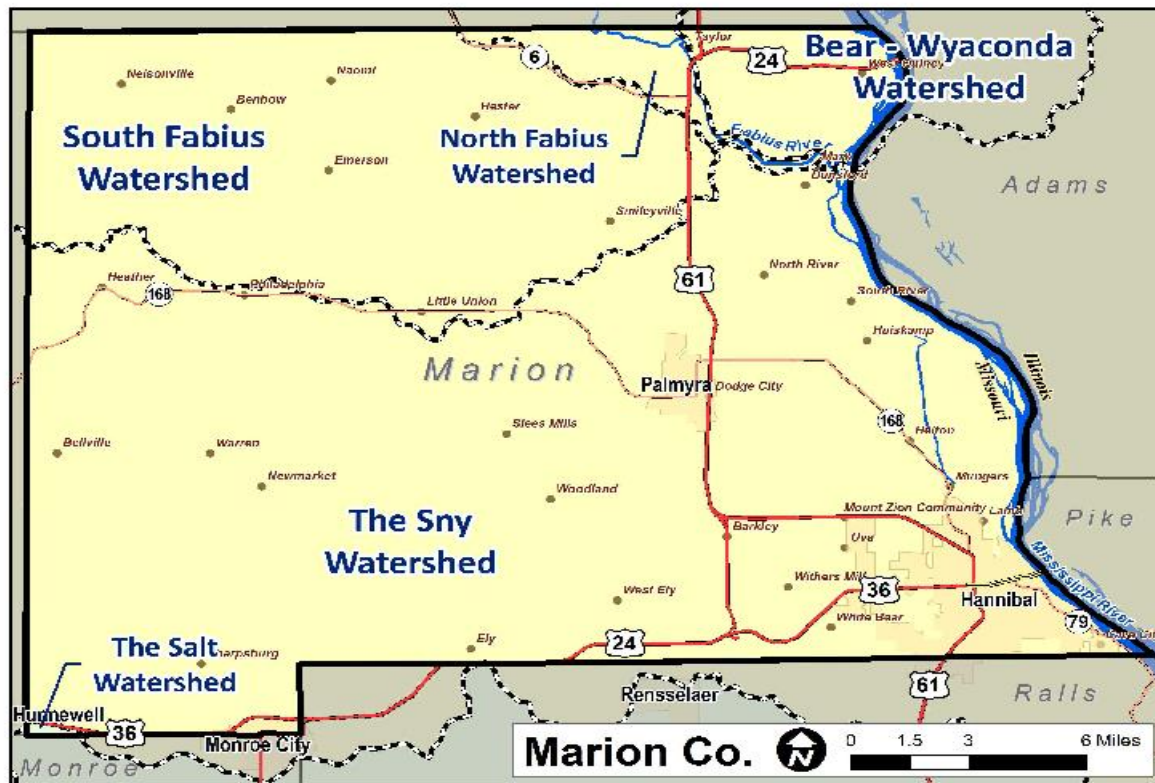
According to US Census data, home values in Marion County increased by 53.9% during the period of 2000-2014. This is slightly higher than that of the Nation (51.5%) and slightly lower than the State at 54.1%. The median value of homes in 2014 in Marion County is \$102,500, while the median value of homes in Missouri is \$138,500 and the Nation is \$181,200.

### 2.1.2 Geography, Geology and Topography

The County has a total of 444 square miles of land and approximately 7.4 square miles is water.

The County is a mix of residents living in unincorporated and incorporated areas. Hannibal is the largest community with a population of 17,606, while Palmyra is home to 3,600 residents according to the US 2010 Census. The remaining population of 7,575 resides in unincorporated areas of the County. Hannibal serves as the economic hub for the Marion County and is driven by the health care and tourism industries. Both of the incorporated areas (Palmyra and Hannibal) have experienced slight but steady population growth. The City of Hannibal is experiencing growth to the west near the hospital. New clinics and hotels are being constructed in this area as well as a new campus for the Moberly Area Community College, convenience store and bank. There are several State and Federal offices located in this area as well.

Marion County is located in part of five HUC 8 watersheds (Sny, South Fabius, North Fabius, Bear-Wyaconda, and Salt River). The map below shows the locations of each watershed and the communities that lie within them. (Source: MO DNR – Our Missouri Waters Program)



Marion County has a moderately hilly terrain, through the eastern part of the county is relatively flat Mississippi River floodplain, which is about five miles wide at the northern county line. The floodplain narrows to about three miles at the northern edge of Hannibal. At Hannibal, the uplands lie adjacent to the river. The Mississippi River floodplain is joined on the west by an abrupt rise of 150 to 200 feet to the upland area. Three major stream systems flowing east to the Mississippi River provide drainage for the upland area of the county. The Fabius River, which drains the northern part of the county has a total drainage area of 1,570 square miles. The North River drains the central and southwestern sector of the Marion County and has a total contributing area of 397 square miles. The South River, which drains the southeastern areas, has a drainage area of 48 square miles. The drainage area of the Mississippi River Basin above Hannibal is 136,500 square miles.

The soil types in the area are Menfor, Winfield and Lindley, which are well-drained. Vegetation consists of grass, panicum and brush plants.



### 2.1.3 Climate

Missouri has a continental type of climate marked by strong seasonality. In the winter, dry-cold air masses, unchallenged by any topographic barriers, periodically swing south from the northern plains and Canada. If they invade, reasonably humid air, snowfall and rainfall result. In the summer, moist warm air masses, equally unchallenged by topographic barriers, swing north from the Gulf of Mexico and can produce copious amounts of rain, either by fronts or by convectional processes. In some summers, high pressure stagnates over Missouri, creating extended droughty periods. Spring and fall are transitional seasons when abrupt changes in temperature and precipitation may occur due to the successive, fast-moving fronts separating contrasting air masses.

While winters are cold and summers are hot in Marion County, prolonged periods of extensive temperatures are unusual but do occur. Occasional periods of mild, above freezing temperatures are noted almost every winter. Conversely, during the peak of summer season, occasional periods of dry-cool weather break up stretches of hot, humid weather. Mean January temperatures for Marion County range from 16.1° F to 33.0° F while July temperatures range from 66.9° F to 86.4° F.

Mean annual precipitation in the Marion County area is 40.17 inches. Precipitation records indicate May as the wettest month, but seasonality is very pronounced due to strong continental influences.

Snow has been known to fall in the Marion County as early as October and as late as May. However most of it falls in December, January and February. Winter snowfall averages 16 to 18 inches. It is unusual for snow to stay on the ground for more than a week or two before it melts. Winter precipitation usually is in the form of rain, snow or both. Conditions sometimes are on the borderline between both rain and snow, and in these situations freezing drizzle/rain occurs. This does not usually happen more than five times in a winter season.

Spring, summer and early fall precipitation comes largely in the form of showers or thunderstorms. Thunderstorms have been observed during winter months, but are most frequent from April to July. Flood producing thunderstorms, with high intensity, short duration rainfalls, can occur anytime but are most experienced from in the spring months. (Source: <http://climate.missouri.edu/climate.php> and Marion County FIS – July, 2016).

### 2.1.4 Population/Demographics

**Figure 2.1 Marion County Population 2000-2010 by Community**

Jurisdiction	2000	2015 Population Estimate	2000-2015 # Change	2000-2015 % Change
Marion County Total	28,289	28,880	591	2.1
City of Hannibal	17,757	17,839	82	.5



City of Palmyra	3,467	3,616	149	4.3
Unincorporated County	7,065	7,425	360	5.1

Source: U.S. Bureau of the Census, Decennial Census, \*population includes the portions of these cities in adjacent counties

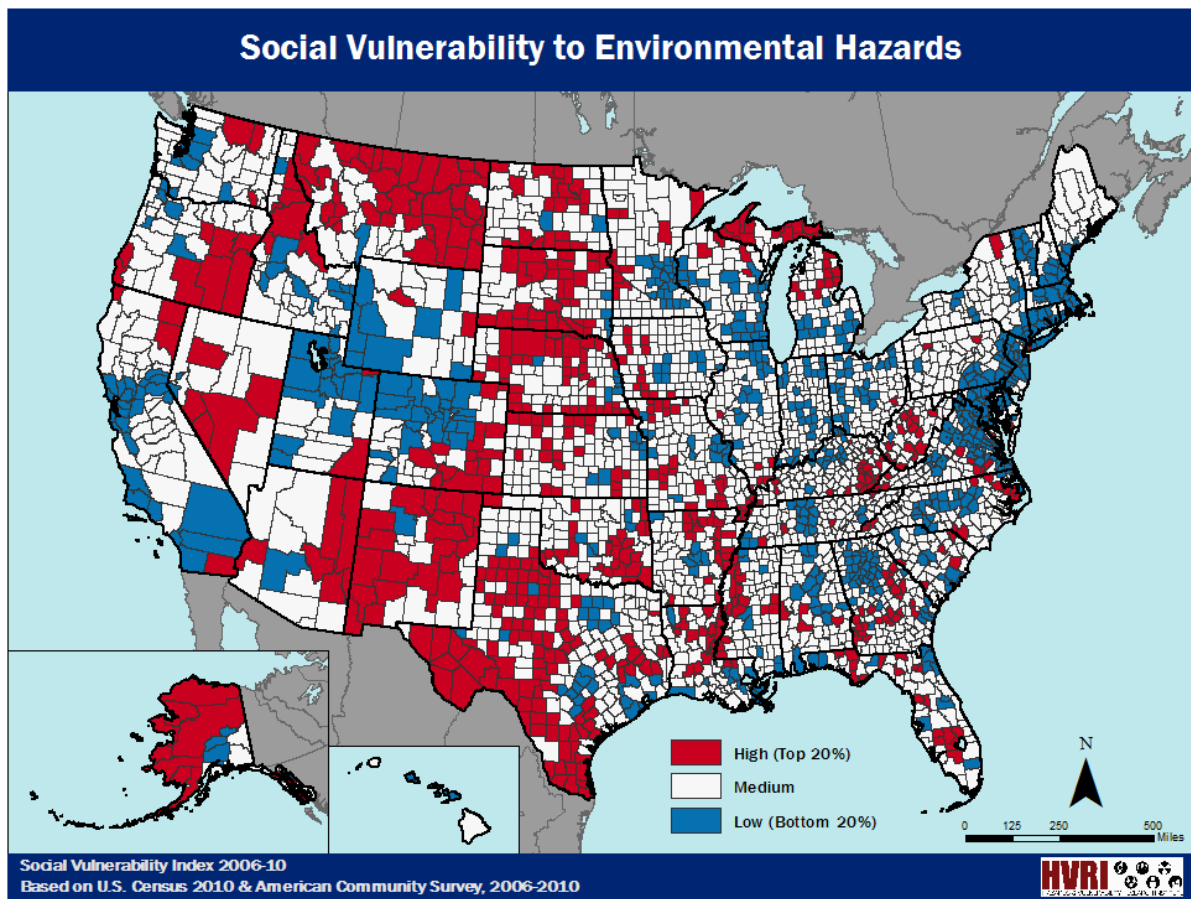
A very small percentage of Monroe City falls within Marion County. This number may be included in the unincorporated total for Marion County thus this number may be slightly skewed and not completely accurate. Also, a small portion of Hannibal lies within Ralls County; conversely this also affects the unincorporated population of Marion County. County projections of population in 2020 are 29,281 and 29,759 in 2030.

According to 2010 Census data, 6.9% of the County's population was under the age of 5 (1,977). This percent aligns closely with the Nation at 6.5% and the State at 6.5%. The County is home to 4,507 (15.7%) residents who are over the age of 65. At the National level 13.0% of residents are 65 and over; while 14.0% of Missourians are 65+. The median age of residents in the County is 39 with the highest percentage of residents falling between the ages of 45-49. The median age of residents of the US is 37.2 with 37.9 being the median age of residents of the State.

There are 11,377 occupied households in the County. The average household size is 2.41 compared to that of the Nation at 2.58 and the State at 2.45. Of the County's occupied households, 3,607 had children under the age of 18 (31.7%) and 27.1 occupied individuals 65 and over. Racial makeup of the County is predominately white (91.8%) with 1.4% of the population being of Hispanic descent.

The University of South Carolina developed an index to evaluate and rank the ability to respond to, cope with, recover from, and adapt to disasters. The index synthesizes 30 socioeconomic variables which research literature suggests contribute to reduction in a community's ability to prepare for, respond to, and recover from hazards. SoVI ® data sources include primarily those from the United States Census Bureau.

ID	State	County	SoIV Score	Nat'l Percentile
1547	Missouri	Marion County	0.574285	62.30 %



According to the SoVI Score and map for Marion County, they have a medium social vulnerability to environmental hazards.

The Table below depicts labor force and unemployment information for July, 2016.

**Table 2.3 Unemployment, Poverty, Education, and Language Percentage Demographics, Marion County, Missouri**

Jurisdiction	Total in Labor Force	Percent of Population Unemployed	Percent of Families Below the Poverty Level	Percentage of Population (High School graduate)	Percentage of Population (Bachelor's degree or higher)	Percentage of population (spoken language other than English)
Marion County	13,989	6.9	13.0	30.6	11.3	.1
City of Hannibal	8,362	7.8	17.0	47.7	9.9	0
City of Palmyra	1,747	7.5	13.7	48.3	9.0	0
Missouri	3,055,604	8.4	11.1	30.0	9.5	1.2

US	158,967,636	9.2	11.5	29.5	9.6	4.5
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Source: U.S. Census, 2011 American Community Survey, 5-year Estimates.

## 2.1.5 History

Marion County was organized on December 23, 1826 from and was named for Revolutionary War folk hero Francis Marion. The County furnished troops for the Black Hawk War in 1832; for the Florida War in 1837; for the Mormon War in 1838; for the Mexican War in 1846; and for the Civil War in 1861.

In the late 1800's, the County was home to sixty churches, sixty-five public schools and four colleges. Unimproved land could be purchased for \$5-10.00 per acre and improved land could be acquired anywhere from \$10 to \$40 per acre.

Hannibal is located along the Mississippi River in northeast Missouri, approximately 100 miles north of St. Louis. The community is intersected by Highway 61 (Avenue of the Saints) and Highway 36 (Chicago to Kansas City Expressway). Hannibal provides convenient, four-lane highway access to St. Louis, Kansas City, Chicago, Memphis, Des Moines, and Minneapolis.

Founded in 1819 by Moses D. Bates, the river town soon flourished as a principal docking port for steamboats, flatboats, and packet steamers traveling the upper Mississippi. By 1845, Hannibal had achieved city status and by 1860, the population had more than doubled, making it the second largest city and third commercial center in Missouri.

Early industries influencing the city's growth include pork packing, soap and candle making, coopering, and milling of lumber. As railroad transportation became less prominent, other businesses ventures took its place, including shoe manufacturing, button making, and cement production.

Hannibal has a proud list of well-known sons and daughters, including William Lear (designer of the Lear jet), Congressman William Henry Hatch, Navy Admiral Robert E. Coontz, sculptor John Rogers, Margaret Tobin (the "Unsinkable" Molly Brown), composer Egbert Van Alstyne, and artist Carroll Beckwith.

Hannibal's most-famous son is Samuel Langhorne Clemens, known worldwide as Mark Twain. At the age of four, Sam's family moved to Hannibal from his birthplace in Florida, Missouri, about thirty miles to the southwest. Many of the popular characters featured in *The Adventures of Tom Sawyer*, *The Adventures of Huckleberry Finn*, and other famous works, were based upon people Sam had known while growing up in Hannibal. Today, visitors can still tour Mark Twain's boyhood home, the Becky Thatcher house, and the famous Mark Twain Cave.

Aside from Hannibal's unique historic district, the community has grown into a thriving haven for artisans, and is included along the famous 50 Miles of Art corridor. The 50 Miles of Art corridor includes a scenic drive along Highway 79, and focuses on the growing art communities of Hannibal, Louisiana, and Clarksville, Missouri. Hannibal is home to

numerous world-class artists and craftsmen.

The City of Palmyra was laid out in 1819 and incorporated in 1820. Historically, the City is best known as the location of the “Palmyra Massacre”. In 1862, what some called the darkest crime of the Civil War, the “Palmyra Massacre,” was committed in Palmyra. Palmyra had been occupied by the Union Army, and local men who refused to join the Union army or who had actively engaged in seditious acts were jailed in the County Jail, which was used as a federal prison during the Civil War. During a raid led by Col Porter of the Missouri Militia (southern forces) to an attempt to free those prisoners, Porter’s men kidnapped a Union sympathizer, 62-year-old Andrew Allsman. The Union forces demanded that Allsman be returned within ten days or ten prisoners would be shot. It was later believed that Allsman had been killed by some of Porter’s men; regardless did not return while Col. William McNeil of the Union Army made good his threat and had ten prisoners executed at the old county fairgrounds. The grounds were never again used as fairgrounds. A monument was erected in the early years of the 20th century dedicated to the ten men who were shot. The jail where the men had been held was built in 1858; it served as the county jail until 1992.

The County is rich in history with many historic properties scattered throughout Hannibal and Palmyra. Below is information indicating historic properties listed on the National Register.

<b>Name on the Register</b>	<b>Date Listed</b>	<b>Location</b>
Levi Barkley House	March 2, 1984	Hannibal
Broadway District	August 1, 1986	Hannibal
207-209 S. Main	August 1, 1986	Hannibal
Central Park Historic District	October 7, 1982	Hannibal
Clemens Field	August 26, 2008	Hannibal
Culbertson-Head Farmstead	September 4, 2008	Palmyra
Davidson Building	August 1, 1986	Hannibal
Digel Block	August 1, 1986	Hannibal
Dryden-Louthan House	January 18, 1985	Palmyra
Ebert-Dulany House	February 17, 1983	Hannibal
8 <sup>th</sup> & Center Street Baptist Church	September 4, 1980	Hannibal
Robert Elliott’s Wholesale Grocery	August 1, 1986	Hannibal
Federal Building	October 15, 1980	Hannibal
Gardner House	March 4, 1971	Palmyra
Green Double House	August 1, 1986	Hannibal
Hafner Grocery Warehouse	August 1, 1986	Hannibal
Hannibal Lime Co. Office	September 6, 1984	Hannibal
Old Police Station and Jail	July 17, 1979	Hannibal
Hendren Farm	August 22, 1984	Hannibal
Hock Building	December 2, 1986	Hannibal
Holmes-Dakin Building	August 1, 1986	Hannibal
Benjamin Horr House	December 2, 1986	Hannibal
Lock & Dam 21 Historic Building	March 10, 2004	West Quincy
Maple Avenue Historic District	November 21, 2002	Hannibal
Marion County Courthouse	October 22, 2002	Hannibal

Marion County Jail & Jailer's House	October 4, 2002	Palmyra
Mark Twain Historic District	January 4, 1978	Hannibal
Mark Twain Hotel	August 1, 1986	Hannibal
Robert Masterson House	April 5, 1984	Hannibal
N. Main Street Historic District	August 1, 1986	Hannibal
Osterhout Mound Park	April 11, 1973	Hannibal
Riverview Park	September 6, 2005	Hannibal
Rockcliffe Mansion	September 8, 1980	Hannibal
St. Elizabeth Hospital	August 14, 2012	Hannibal
Sharkey Mound Group	December 18, 1973	Hannibal
Peter J. Sowers House	January 18, 1985	Palmyra
Speigle House	February 14, 1985	Palmyra
Standard Printing Company	August 1, 1986	Hannibal
Mark Twain Boyhood Home	October 15, 1966	Hannibal
Walker-Woodward Schaffer House	February 16, 1984	Palmyra
Ephraim J. Wilson Farm Complex	December 28, 1982	Palmyra

The Hannibal Public School District No. 60 consists of the Veterans Elementary School, A.D. Stowell Elementary, Mark Twain Elementary, Oakwood Elementary, Eugene Field Elementary, Hannibal Middle School and Hannibal High School. The Palmyra R-1 School District consists of an elementary (K-4), middle school (5-8) and high school (9-12). Also located in the County is the Marion County R-II School District located in Philadelphia which has an elementary (K-6) and high school (7-12). Private schools in Marion County include the Holy Family Catholic School and St. John's Lutheran School, both located in Hannibal. The Moberly Area Community College also has a campus in Hannibal as does Hannibal-LaGrange University – a four year private Baptist university.

## 2.1.6 Occupations

**Table 2.4 Occupation Statistics, Marion County, Missouri**

Place	Management, Business, Science, and Arts Occupations	Service Occupations	Sales and Office Occupations	Natural Resources, Construction, and Maintenance Occupations	Production, Transportation, and Material Moving Occupations
Marion County	30.7	18.5	21.2	10.0	19.6
City of Hannibal	29.9	19.3	21.8	8.2	20.8
City of Palmyra	27.9	20.6	26.5	8.8	16.1

Source: U.S. Census, 2011 American Community Survey, 5-year Estimates.



## 2.1.7 Agriculture

2012	Marion Co.	State Rank	
<b>Market Value of Agricultural Products Sold (\$1,000)</b>			
Total value of agricultural products sold	87,121	34	
Value of crops including nursery and greenhouse	53,674	25	
Value of livestock, poultry and their products	33,447	43	
<b>Top Crop Items (Acres)</b>			
Corn for grain	63,416	19	
Soybeans for beans	60,506		
Forage-land used for hay, grass, silage and greenchop	13,248	98	
Wheat for grain (all wheat)	6,602	31	
Winter wheat for grain	6,602	31	
<b>Top Livestock Inventory Items (number)</b>			
Hogs and pigs	48,944	12	
Cattle and Calves	15,351	91	
Sheep and lambs	631	57	
Horses and ponies	523	89	
	<b>2,012</b>	<b>2007</b>	<b>% Change</b>
<b>Number of Farms</b>	704	749	-6
Land in Farms (acres)	221,469	237,016	-7
Average Size of Farm (acres)	315	316	0
<b>Market Value of Products Sold</b>	\$87,121,000	\$76,526,000	14
Crop Sales \$53,674,000 (62%)			
Livestock Sales \$33,4447,000 (38%)			
Average Per Farm	\$123,751.00	\$102,171	21
<b>Government Payments</b>	\$3,060,000	\$3,030,000	1
Average Per Farm Receiving Payments	\$6,108	\$5,372	14
<i>Source: www.agcensus.usda.gov</i>			

## 2.1.8 Hazard Mitigation Assistance Grants in Planning Area

**Table 2.5 FEMA HMA Grants in Marion County from 1993-2014**

Project Type	Sub applicant	Award Date	Project Total
Acquisition	Marion County	July, 1993	918,787
Acquisition	Hannibal	July, 1993	1,223,477
Acquisition	City of Hannibal	December, 2007	442,230
Safe Room	Moberly Area Community College	February, 2009	1,700,321

Source: Missouri State Emergency Management Agency,

## 2.2 Jurisdictional Profiles and Mitigation Capabilities

### 2.2.1 Marion County

By Missouri Statute (Section 48.020.1) Marion County is defined as a 3<sup>rd</sup> Class County, meaning its assessed valuation is less than six hundred million dollars. The County seat is located in Palmyra. As a result of the addition of the Court of Common Pleas, Marion County is unique from most third class counties in that it has two courthouses the second located in Hannibal.

Marion County has eight townships, which serve today primarily as voting districts. The county government provides services such as law enforcement, judicial services, land records, tax collection, property assessment, administration of elections, construction and maintenance of road and bridges and zoning.

The County is governed by an elected board of Commissioners composed of a presiding commissioner and two associate commissioners. Other positions within Marion County's government include:

- County Assessor
- County Clerk
- County Recorder
- County Sheriff
- County Collector
- Emergency Management

- County Coordinator
- Coroner
- Circuit Clerk
- Public Administrator
- Prosecuting Attorney
- County Treasurer

### ***Mitigation Initiatives/Capabilities***

The County of Marion as well as the Cities of Hannibal and Palmyra have implemented zoning and building requirements which govern development within the County. The County also has an Emergency Manager. The Manger plans and directs disaster responses or crisis management activities, provides disaster preparedness training and prepares emergency plans and procedures for natural disasters.

The Marion County Coordinator acts as the Floodplain Manager for the County and is the principal administrator in the daily implementation of flood loss reduction activities including enforcing flood damage prevention and related policies and any of the activities related to administration of the Nation Flood Insurance Program (NFIP). The Coordinator is also responsible for overseeing zoning activities.

The County has an Emergency Operations Plan, Land Use Order, Floodplain Management Ordinance/Floodplain Development Procedures, and an Emergency Operations Plan – Hazardous Materials Response manual. Outdoor warning sirens are located strategically in Hannibal and Palmyra. The County has a “Code Red Emergency Notification System” to alert residents of the County of imminent danger.

**Table 2.6 Unincorporated Marion County Mitigation Capabilities**

<b>Capabilities</b>	<b>Status Including Date of Document or Policy</b>
Planning Capabilities	
Comprehensive Plan	No
Builder's Plan	No
Capital Improvement Plan	No
Local Emergency Plan	No
County Emergency Plan	Yes Revised in 2015
Local Recovery Plan	No
County Recovery Plan	No
Local Mitigation Plan	No
County Mitigation Plan	Yes
Local Mitigation Plan (PDM)	No
County Mitigation Plan (PDM)	Yes
Economic Development Plan	No
Transportation Plan	Yes (Included in Mark Twain Regional COG Trans.
Land-use Plan	Yes
Flood Mitigation Assistance (FMA) Plan	No
Watershed Plan	No
Firewise or other fire mitigation plan	No

School Mitigation Plan	No
Critical Facilities Plan (Mitigation/Response/Recovery)	No
Policies/Ordinance	
Zoning Ordinance	Yes (Land Use Order August 2013)
Building Code	No
Floodplain Ordinance	Yes (Revised 2013)
Subdivision Ordinance	No
Tree Trimming Ordinance	No
Nuisance Ordinance	No
Storm Water Ordinance	No
Drainage Ordinance	No
Site Plan Review Requirements	Yes
Historic Preservation Ordinance	No
Landscape Ordinance	No
Iowa Wetlands and Riparian Areas Conservation Plan	No
Debris Management Plan	No
Program	
Zoning/Land Use Restrictions	Yes
Codes Building Site/Design	No
National Flood Insurance Program (NFIP) Participant - Nondelegated	Yes
NFIP Community Rating System (CRS) Participating Community	No
Hazard Awareness Program	No
National Weather Service (NWS) Storm Ready	No
Building Code Effectiveness Grading (BCEGs)	No
ISO Fire Rating	No
<b>Capabilities</b>	<b>Status Including Date of Document or Policy</b>
Economic Development Program	No
Land Use Program	No
Public Education/Awareness	Yes
Property Acquisition	No
Planning/Zoning Boards	Yes
Stream Maintenance Program	No
Tree Trimming Program	No
Engineering Studies for Streams (Local/County/Regional)	No
Mutual Aid Agreements	Yes (Fire and Law Enforcement)
Studies/Reports/Maps	
Hazard Analysis/Risk Assessment (Local)	No
Hazard Analysis/Risk Assessment (County)	Yes
Flood Insurance Maps	Yes
FEMA Flood Insurance Study (Detailed)	Yes
Evacuation Route Map	No
Critical Facilities Inventory	Yes
Vulnerable Population Inventory	No
Land Use Map	Yes
Staff/Department	
Building Code Official	No
Building Inspector	No

Mapping Specialist (GIS)	No
Engineer	No
Development Planner	No
Public Works Official	No
Emergency Management Director	Yes
NFIP Floodplain Administrator	Yes
Bomb and/or Arson Squad	No
Emergency Response Team	No
Hazardous Materials Expert	Yes
Local Emergency Planning Committee	Yes
County Emergency Management Commission	No
Sanitation Department	No
Transportation Department	Yes
Economic Development Department	No
Housing Department	No
Planning Consultant	No
Regional Planning Agencies	Yes
Historic Preservation	No
<b>Non-Governmental Organizations (NGOs)</b>	
American Red Cross	No
Salvation Army	Yes
Veterans Groups	Yes
Environmental Organization	No
Homeowner Associations	No
Neighborhood Associations	No
Chamber of Commerce	Yes
Community Organizations (Lions, Kiwanis, etc.)	Yes
<b>Local Funding Availability</b>	
Ability to apply for Community Development Block Grants	Yes
Ability to fund projects through Capital Improvements funding	Yes
<b>Capabilities</b>	<b>Status Including Date of Document or Policy</b>
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	
Impact fees for new development	Yes
Ability to incur debt through general obligation bonds	Yes
Ability to incur debt through special tax bonds	Yes
Ability to incur debt through private activities	No
Ability to withhold spending in hazard prone areas	No

Source: Data Collection Questionnaire, 2016\_\_

The answers to the above questionnaire were provided by the Marion County Coordinator. Dates were not available in all cases.

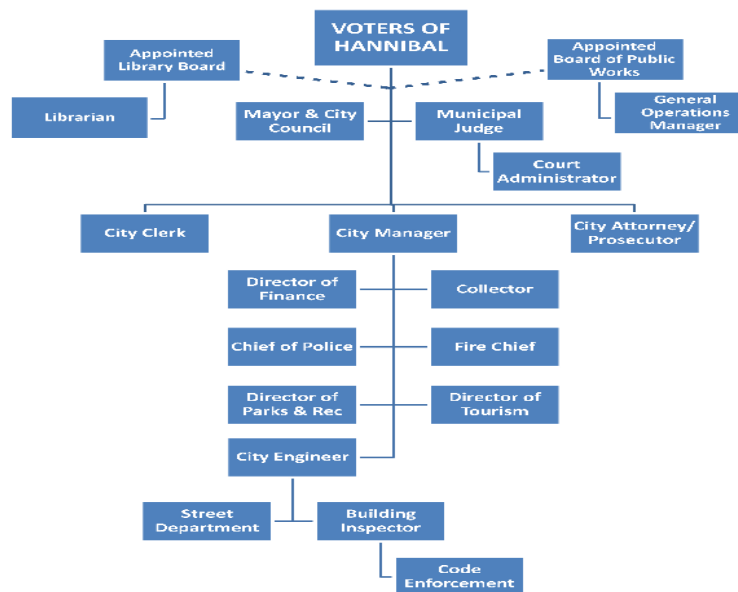
### 2.2.2 City of Hannibal

Hannibal is a community of 17,916 people and is located on the eastern side of the County adjacent to the Mississippi River. The City is comprised of fourteen basic departments or functions which include the Executive branch (including City Council, City Clerk, Collector, Public Works and Streets,



Building Inspections, Parks and Recreation, Police, Fire, Municipal Court, Library, Emergency Management, Airport, Tourism and Hannibal Board of Public Works. Under a Home Rule Charter, the City of Hannibal uses a Council/Manager form of city government.

The mayor is elected at large for a three-year term and each of the six City Council members are elected, one per each ward for a staggered three year term. Under the Council/Manager form of government, the elected Mayor and City Council set policy and overall direction for the City. The City staff, under direction of the City manager, carries out Council decisions and provides day-to-day services. The City's organization structure is very diverse and is shown in the chart below:



According to Census estimates Hannibal is experiencing a decline in population. The City's 2010 population was sited at 17,916 while 2015 estimates reveal a population of 17,839 a slight decline of .4%.

The City of Hannibal and various departments host a variety of public education programs throughout the year. Included are an energy conservation committee, fire safety programs for senior centers and schools, a fire-starters program for youth, emergency management educational seminars, a citizens police academy, live –shooter training for businesses sponsored by the Hannibal Police Department and tornado spotters training to name a few.

Since 2011, the City has acquired 42 flood impacted properties through hazard mitigation grants. Acquisition and demolition of these sites has removed lives and properties from future endangerment. In addition, the City has acquired approximately 10 flood impacted properties outside the scope of the hazard mitigation grant program for the same purpose.

In 2015, the City enacted a program called “Tornado Shelter Alternatives”, whereby local churches provide basements to persons seeking a higher level of shelter during tornado watches and warnings. This program was designed to provide a greater level of safety for persons living in homes lacking basements or those residing in mobile homes. It also will provide a means of shelter for tourists and pedestrians without immediate shelter. There is only one FEMA certified storm shelter in Hannibal which is owned by the Moberly Area Community College. Due to the shortage of shelters, the Tornado Shelter Alternative is available to anyone in the community. There are approximately 16

outdoor warning sirens strategically located throughout the community.

The community utilizes a public contact system called Code Red. The Code Red system, administered by the Marion County 911 dispatch, has the capability to send voice and/or text messages to every home, business, mobile phone or communications device in the County, provided members of the public have enrolled for the service. The Code Red system has been used to alert the public school regarding tornado warnings, severe storms, missing children, and even a bank robber who was temporarily at large.

Discuss the general location of the city in the county, Mayor/Council or Board of Alderman, how many elected positions, most recent census population compared to 2000, percentage growth or decline. Discuss each community's specific mitigation initiatives, such as:

Downtown buildings in Hannibal are aging and deteriorating at a rapid pace. They are at risk for failure with two collapsing within the past five years. Time and the elements have taken a toll of many of the structures and the cost of maintenance for many property owners is prohibitive.

The information in Table 2.7 was provided by Hannibal City Manager Jeff LaGarce.

**Table 2.7 City of Hannibal Mitigation Capabilities**

<b>Capability</b>	<b>Status Including Date of Document or Policy</b>
Planning Capabilities	
Comprehensive Plan	Yes 2009
Builder's Plan	Building Codes (International Building Codes)
Capital Improvement Plan	Yes 2015
Local Emergency Plan	Yes Updated 2015
County Emergency Plan	NA
Local Recovery Plan	No
County Recovery Plan	NA
Local Mitigation Plan	Yes
County Mitigation Plan	NA
Local Mitigation Plan (PDM)	No
County Mitigation Plan (PDM)	NA
Economic Development Plan	Yes 2013
Transportation Plan	Included in Mark Twain COG Regional Plan
Land-use Plan	Yes 2009
Flood Mitigation Assistance (FMA) Plan	NA
Watershed Plan	Yes 2009
Firewise or other fire mitigation plan	Yes 2010 (Firestarter Program)
School Mitigation Plan	No
Critical Facilities Plan (Mitigation/Response/Recovery)	No
<b>Policies/Ordinance</b>	<b>Status Including Date of Document or Policy</b>
Zoning Ordinance	Yes
Building Code	Yes 2012 Version of International Codes
Floodplain Ordinance	Yes – Updated frequently
Subdivision Ordinance	No
Tree Trimming Ordinance	No
Nuisance Ordinance	Yes
Storm Water Ordinance	Yes
Drainage Ordinance	Yes
<b>Capability</b>	<b>Status Including Date of Document or Policy</b>
Site Plan Review Requirements	Yes
Historic Preservation Ordinance	Yes

Landscape Ordinance	Yes
Iowa Wetlands and Riparian Areas Conservation Plan	NA
Debris Management Plan	Yes
<b>Program</b>	<b>Status Including Date of Document or Policy</b>
Zoning/Land Use Restrictions	Yes
Codes Building Site/Design	Yes
National Flood Insurance Program (NFIP) Participant - Nondelegated	Yes
NFIP Community Rating System (CRS) Participating Community	Yes - 8
Hazard Awareness Program	No
National Weather Service (NWS) Storm Ready	Yes
Building Code Effectiveness Grading (BCEGs)	Yes
ISO Fire Rating	3
Economic Development Program	Yes
Land Use Program	Yes
Public Education/Awareness	Yes
Property Acquisition	Yes
Planning/Zoning Boards	Yes
Stream Maintenance Program	Yes
Tree Trimming Program	Yes
Engineering Studies for Streams (Local/County/Regional)	Yes
Mutual Aid Agreements	Yes
<b>Studies/Reports/Maps</b>	<b>Status Including Date of Document or Policy</b>
Hazard Analysis/Risk Assessment (Local)	Yes
Hazard Analysis/Risk Assessment (County)	NA
Flood Insurance Maps	Yes
FEMA Flood Insurance Study (Detailed)	Yes
Evacuation Route Map	No
Critical Facilities Inventory	Yes
Vulnerable Population Inventory	No
Land Use Map	Yes
<b>Staff/Department</b>	<b>Status Including Date of Document or Policy</b>
Building Code Official	Yes
Building Inspector	Yes
Mapping Specialist (GIS)	No
Engineer	Yes – Contract with private firm
Development Planner	No
Public Works Official	Yes
Emergency Management Coordinator	Yes
NFIP Floodplain Administrator	Yes
Bomb and/or Arson Squad	Utilize Highway Patrol or MO National Guard
Emergency Response Team	Yes
Hazardous Materials Expert	Yes
Local Emergency Planning Committee	Yes
County Emergency Management Commission	NA
Sanitation Department	Yes
Transportation Department	Yes
Economic Development Department	Yes
Housing Department	Yes
Planning Consultant	No
Regional Planning Agencies	Yes
Historic Preservation	Yes
<b>Non-Governmental Organizations (NGOs)</b>	<b>Status Including Date of Document or Policy</b>
American Red Cross	No
Salvation Army	Yes
<b>Capability</b>	<b>Status Including Date of Document or Policy</b>

Veterans Groups	Yes
Environmental Organization	No
Homeowner Associations	Yes
Neighborhood Associations	Yes
Chamber of Commerce	Yes
Community Organizations (Lions, Kiwanis, etc.)	Yes
<b>Local Funding Availability</b>	<b>Status Including Date of Document or Policy</b>
Ability to apply for Community Development Block Grants	Yes
Ability to fund projects through Capital Improvements funding	Yes
Authority to levy taxes for a specific purpose	Yes
Fees for water, sewer, gas, or electric services	Yes
Impact fees for new development	Yes
Ability to incur dept through general obligation bonds	Yes
Ability to incur debt through special tax bonds	Yes
Ability to incur debt through private activities	No
Ability to withhold spending in hazard prone areas	Yes

Source: Data Collection Questionnaire

**Table 2.8 Mitigation Capabilities Summary Table**

CAPABILITIES	Uninc. Marion County	City of Hannibal	
<b>Planning Capabilities</b>			
Comprehensive Plan	No	Yes	
Builder's Plan	No	Yes	
Capital Improvement Plan	No	Yes	
Local Emergency Plan	No	Yes	
County Emergency Plan	Yes	No	
Local Recovery Plan	No	No	
County Recovery Plan	No	No	
Local Mitigation Plan	No	Yes	
County Mitigation Plan	Yes	No	
Local Mitigation Plan (PDM)	No	No	
County Mitigation Plan (PDM)	No	No	
Debris Management Plan	No	No	
Economic Development Plan	No	Yes	
Transportation Plan	Yes	Yes	
Land-use Plan	No	Yes	
Flood Mitigation Assistance (FMA) Plan	No	No	
Watershed Plan	No	Yes	
Firewise or other fire mitigation plan	No	Yes	
School Mitigation Plan	No	No	

CAPABILITIES	Uninc. Marion County	City of Hannibal	
Critical Facilities Plan (Mitigation/Response/Recovery )	No	Yes	
<b>Policies/Ordinance</b>			
Zoning Ordinance	Yes	Yes	
Building Code	No	Yes	
Floodplain Ordinance	Yes	Yes	
Subdivision Ordinance	No	Yes	
Tree Trimming Ordinance	No	Yes	
Nuisance Ordinance	No	Yes	
Storm Water Ordinance	No	Yes	
Drainage Ordinance	No	Yes	
Site Plan Review Requirements	Yes	Yes	
Historic Preservation Ordinance	No	Yes	
Landscape Ordinance	No	Yes	
Iowa Wetlands and Riparian Areas Conservation Plan	No	No	
<b>Program</b>			
Zoning/Land Use Restrictions	Yes	Yes	
Codes Building Site/Design	No	Yes	
National Flood Insurance Program (NFIP) Participant - Nondelegated	No	No	
NFIP Participant - Delegated	Yes	Yes	
NFIP Community Rating System (CRS) Participating Community	No	Yes	
Hazard Awareness Program	No	Yes	
National Weather Service (NWS) Storm Ready	No	Yes	
Building Code Effectiveness Grading (BCEGs)	No	Yes	
ISO Fire Rating	No	3	
Economic Development Program	No	Yes	
Land Use Program	No	Yes	
Public Education/Awareness	Yes	Yes	
Property Acquisition	No	Yes	
Planning/Zoning Boards	Yes	Yes	
Stream Maintenance Program	No	Yes	
Tree Trimming Program	No	Yes	
Engineering Studies for Streams (Local/County/Regional)	No	Yes	
Mutual Aid Agreements	Yes	Yes	
<b>Studies/Reports/Maps</b>			



CAPABILITIES	Uninc. Marion County	City of Hannibal	
Hazard Analysis/Risk Assessment (Local)	No	Yes	
Hazard Analysis/Risk Assessment (County)	Yes	NA	
Flood Insurance Maps	Yes	Yes	
FEMA Flood Insurance Study (Detailed)	Yes	Yes	
Evacuation Route Map	No	No	
Critical Facilities Inventory	Yes	Yes	
Vulnerable Population Inventory	No	No	
Land Use Map	Yes	Yes	
<b>Staff/Department</b>			
Building Code Official	No	Yes	
Building Inspector	No	Yes	
Mapping Specialist (GIS)	No	No	
Engineer	No	Yes	
Development Planner	No	No	
Public Works Official	No	Yes	
Emergency Management Coordinator	Yes	Yes	
NFIP Floodplain Administrator	Yes	Yes	
Bomb and/or Arson Squad	No	Yes	
Emergency Response Team	No	Yes	
Hazardous Materials Expert	No	Yes	
Local Emergency Planning Committee	Yes	Yes	
County Emergency Management Commission	Yes	NA	
Sanitation Department	No	Yes	
Transportation Department	No	Yes	
Economic Development Department	No	Yes	
Housing Department	No	Yes	
Planning Consultant	No	No	
Regional Planning Agencies	Yes	Yes	
Historic Preservation	No	Yes	
<b>Non-Governmental Organizations (NGOs)</b>			
American Red Cross	No	No	
Salvation Army	Yes	Yes	
Veterans Groups	No	Yes	
Environmental Organization	No	Yes	
Homeowner Associations	No	Yes	

CAPABILITIES	Uninc. Marion County	City of Hannibal	
Neighborhood Associations	No	Yes	
Chamber of Commerce	Yes	Yes	
Community Organizations (Lions, Kiwanis, etc.)	Yes	Yes	
<b>Financial Resources</b>			
Apply for Community Development Block Grants	Yes	Yes	
Fund projects through Capital Improvements funding	Yes	Yes	
Authority to levy taxes for specific purposes	Yes	Yes	
Fees for water, sewer, gas, or electric services	No	Yes	
Impact fees for new development	Yes	Yes	
Incur dept through general obligation bonds	Yes	Yes	
Incur debt through special tax bonds	Yes	Yes	
Incur debt through private activities	No	No	
Withhold spending in hazard prone areas	Yes	Yes	

Source: Data Collection Questionnaires, date

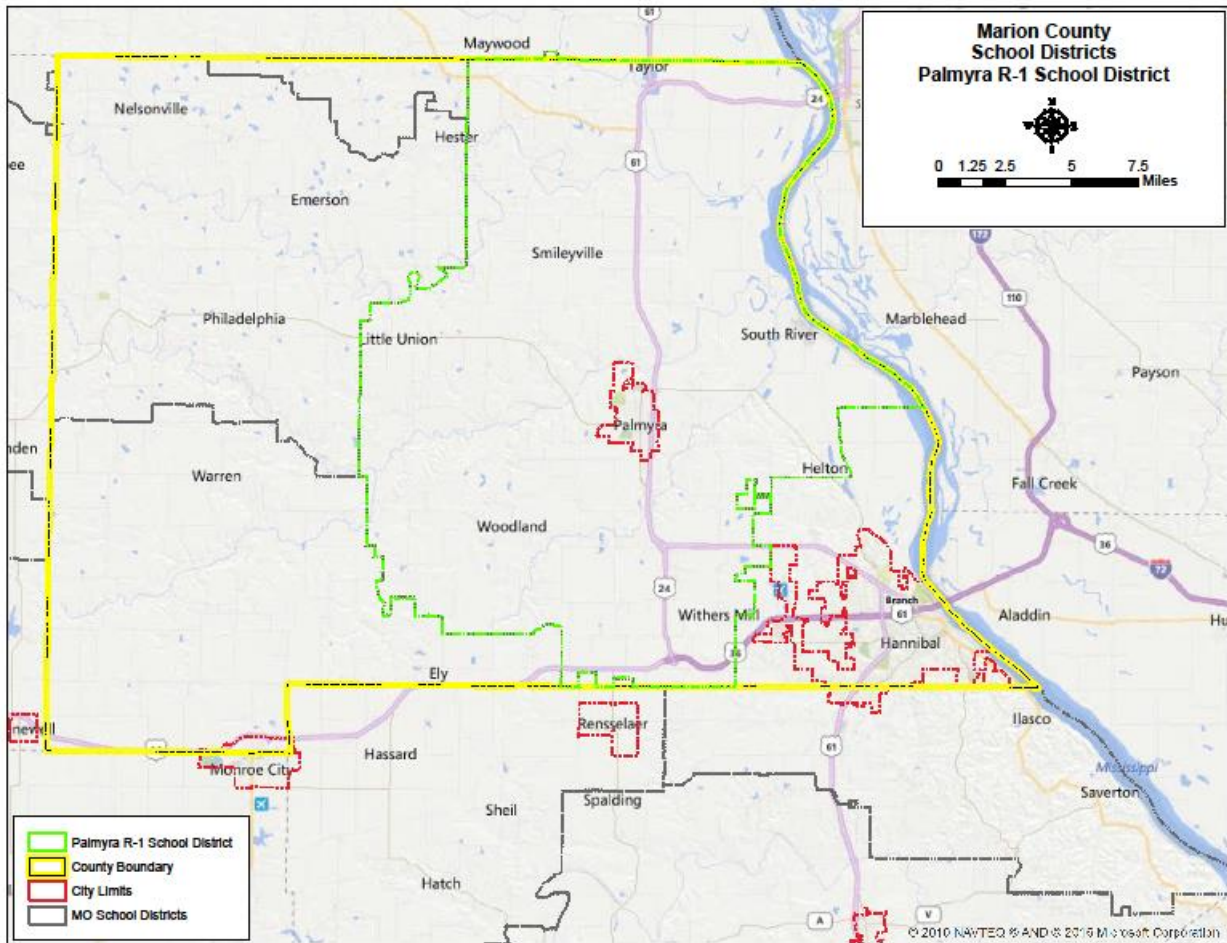
### 2.2.3 Special District

No special districts participated in the Marion County planning process.

### 2.2.4 Public School District Profiles and Mitigation Capabilities

There are three public schools in the Marion County (Marion County R-II, Hannibal Public Schools and Palmyra R-I). The only school participating the planning activities is the Palmyra R-I School District. There is also one community college (Moberly Area Community College) and one private university (Hannibal LaGrange University). Neither of these educational institutions chose to participate in the planning process either.

Below is a map outlining the Palmyra R-1 School district boundaries (in green).



Palmyra R-1 School District

	Schools	Certified Staff	Enrollment (Prior Year)		
			Residents	Non-Res.	Total
<b>Elementary Schools</b>	1	42	415	1	416
<b>Middle Schools</b>	1	31	330	0	330
<b>High Schools</b>	1	36	353	0	353
<b>Total</b>	3	109	1098	1	1099
		District	MO		
<b>Free/Reduced Lunch</b>		35.50%	51.7		
<b>% White</b>		94.1	72.8		
<b>Student/Teacher Ratio</b>		12/1	13/1		
<b>Palmyra High School</b>	1703 S. Main Street Palmyra, MO 63461 573-769-2067 Grade Span: 9-12 Principal: Mr. Jared Pontius				
<b>Palmyra Middle School</b>	600 W. Line Street Palmyra, MO 63461 573-769-2174 Grade Span: 5-8 Principal: Mr. Michael Malone				
<b>Palmyra Elementary</b>	600 S. Ashland Palmyra, MO 63461 573-769-3736 Grade Span: K-4 Principal: Mrs. Lora Hillman				
<b>Superintendent of Schools - Mr. Eric Churchwell</b>					

Palmyra School District - Buildings and Enrollment Data, 2015

District Name	Building Name	Building Enrolment
Palmyra R-1 School District	Elementary	416
Palmyra R-1 School District	Middle School	330
Palmyra R-1 School District	High School	353

<http://mcds.dese.mo.gov/quickfacts/Pages/District-and-School-Information.aspx>

Table 2.8 Summary of Mitigation Capabilities-Palmyra R-1 School District

<b>Capability</b>	<b>Palmyra R-1 School District</b>	
<b>Planning Elements</b>		
Master Plan/ Date	Yes	
Capital Improvement Plan/Date	Yes	
School Emergency Plan / Date	Yes (Aug. 2015)	
Weapons Policy/Date	No	
<b>Personnel Resources</b>		
Full-Time Building Official (Principal)	Yes	
Emergency Manager	No	
Grant Writer	No	
Public Information Officer	No	
<b>Financial Resources</b>		
Capital Improvements Project Funding	Yes	
Local Funds	Yes	
General Obligation Bonds	No	
Special Tax Bonds	No	
Private Activities/Donations	No	
State And Federal Funds/Grants	No	
<b>Other</b>		
Public Education Programs	Yes	
<b>Capability</b>	<b>Palmyra R-1 School District</b>	
Privately Or Self-Insured?	Privately	
Fire Evacuation Training	Yes	
Tornado Sheltering Exercises	Yes	
Public Address/Emergency Alert System	Yes	
NOAA Weather Radios	Yes	
Lock-Down Security Training	Yes	
Mitigation Programs	No	
Tornado Shelter/Saferoom	Yes	
Campus Police	No	

Data Collection Questionnaires, 2016

## 3 RISK ASSESSMENT

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**44 CFR Requirement §201.6(c)(2): [The plan shall include] A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.**

The goal of the risk assessment is to estimate the potential loss in the planning area, including loss of life, personal injury, property damage, and economic loss, from a hazard event. The risk assessment process allows communities and school/special districts in the planning area to better understand their potential risk to the identified hazards. It will provide a framework for developing and prioritizing mitigation actions to reduce risk from future hazard events.

#### Changes in this Version

The risk assessment in this plan consolidates, updates, and streamlines content from the 2010 approved plan. Content has been restructured to cover a broad range of emerging hazards, vulnerabilities, and risk issues. Significant changes have been made that include standardized terminology, new GIS-based ranking methodology which assesses hazard risk by jurisdiction, new analysis for all major hazards, development of annualized loss by jurisdiction and review of local risk assessments, land use planning, and development.

This chapter is divided into four main parts:

- **Section 3.1 Hazard Identification** identifies the hazards that threaten the planning area and provides a factual basis for elimination of hazards from further consideration;
- **Section 3.2 Assets at Risk** provides the planning area's total exposure to natural hazards, considering critical facilities and other community assets at risk;
- **Section 3.3 Future Land Use and Development** discusses areas of planned future development
- **Section 3.4 Hazard Profiles and Vulnerability Analysis** provides more detailed information about the hazards impacting the planning area. For each hazard, there are three sections: 1) Hazard Profile provides a general description and discusses the threat to the planning area, the geographic location at risk, potential severity/magnitude/extent, previous occurrences of hazard events, probability of future occurrence, risk summary by jurisdiction, impact of future development on the risk; 2) Vulnerability Assessment further defines and quantifies populations, buildings, critical facilities, and other community/school or special district assets at risk to natural hazards; and 3) Problem Statement briefly summarizes the problem and develops possible solutions.

## 3.1 Hazard Identification

**Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the type...of all natural hazards that can affect the jurisdiction.**

Natural hazard can be complex, occurring with a wide range of intensities. Some events are instantaneous and offer no window of warning, such as earthquakes. Some offer a short warning in which to alert the public to take actions, such as tornadoes or severe thunderstorms. Others occur less frequently and are typically more expansive, with some warning time to allow the public time to prepare, such as flooding.

Each year there are increases in human-caused incidents, which can be just as devastating as natural disasters. For the purpose of this plan “human-caused hazards” are technological hazards and terrorism. These are distinct from natural hazards primarily in that they originate from human activity. In contrast, while the risks presented by natural hazards may be increased or decreased as a result of human activity, they are not inherently human-induced. The term “technological hazards” refers to the origins of incidents that can arise from human activities such as the manufacture, transportation, storage, and use of hazardous materials. For the sake of simplicity, this guide assumes that technological emergencies are accidental and that their consequences are unintended.

### 3.1.1 Review of Existing Mitigation Plans

The MPC previously developed a multi-jurisdiction Hazard Mitigation Plan dated 2010 and the City of Hannibal, Palmyra R-1 and Marion County participated in the multi-jurisdictional county-wide plan. The 2010 Hazard Mitigation Plan was consulted in development of the risk assessment and information included and updated where appropriate. The hazards included in the 2010 Marion County Hazard Mitigation Plan are listed in Table 3.1

**Table 3.1 Hazards Included in the Marion County 2010 Hazard Mitigation Plan**

- |                     |                         |
|---------------------|-------------------------|
| • Tornado           | • Thunderstorm          |
| • Flood             | • Severe Winter Weather |
| • Drought/Heat Wave | • Earthquake            |
| • Dam Failure       | • Wildfire              |
| • Levee Failure     | • Landslide             |
| • Sinkholes         |                         |

To facilitate consistency within the planning efforts in the State, and to enable comprehensive statewide analysis, of local plans the MPC considered each of the 21 hazards included in the 2013 Missouri State Hazard Mitigation Plan. The MPC reviewed data and discussed the impacts of each of these hazards. Table 3.2 below provides the full list of hazards in the State Hazard Mitigation Plan.

**Table 3.2 Hazards Included in the 2013 Missouri State Hazard Mitigation Plan**

- Riverine Flooding (Major and Flash)
- Levee Failure
- Land Subsidence/Sinkholes
- Severe Thunderstorm (includes damaging winds, hail and lightening)
- Severe Winter Weather/Snow/Ice/Severe Cold
- Droughts
- Fires (Structural, Urban, and Wild)
- Civil Disorder
- Hazardous Materials Release (Fixed Facility Accidents/Transportation Accidents)
- Mass Transportation Accident
- Public Health Emergencies/Environmental Issues
- Special Events
- Utilities (Interruptions and System Failures)
- Dam Failure
- Earthquake
- Tornadoes
- Extreme Temperatures
- Attack (Nuclear, Conventional, and Biological)
- Cyber Disruption
- Nuclear Power Plants (Emergencies and Accidents)
- Terrorism

The MPC decided to include only natural hazards, as only natural hazards are required by federal regulations to be included. The human-caused and technological hazards were eliminated from further analysis due to these hazards are not necessary for plans to meet the requirements of the Disaster Mitigation Act of 2000.

### 3.1.2 Review of Disaster Declaration History

Declarations may be granted when the severity and magnitude of an event surpasses the ability of the local government to respond and recover. Disaster assistance is supplemental and sequential. When the local government's capacity has been surpassed, a state disaster declaration may be issued, allowing for the provision of state assistance. If the disaster is so severe that both the local and state governments' capacities are exceeded; a federal emergency or disaster declaration may be issued allowing for the provision of federal assistance.

FEMA also issues emergency declarations, which are more limited in scope and do not include the long-term federal recovery programs of major disaster declarations. Determinations for declaration type are based on scale and type of damages and institutions or industrial sectors affected.

**Table 3.3 FEMA Disaster Declarations that included Marion County, Missouri, 1990-Present**

Disaster Number	Description	Declaration Date Incident Period	Individual Assistance (IA) Public Assistance (PA)
DR-4238	Severe Storms, Tornadoes, Straight-line Winds and Flood	August 7, 2015 May 15, 2015 to July 27, 2015	Public Assistance
DR-4130	Severe Storms, Tornadoes, Straight-line Winds and Flood	July 18, 2013 May 29, 2013 to June 11, 2013	Public Assistance
DR-1961	Severe Winter Storms and Snow Storms	March 23, 2011 January 31, 2011 to February 5, 2011	Public Assistance
EM-3317	Severe Winter Storm	February 3, 2011 January 31, 2011 to February 5, 2011	Individual Assistance
DR-1934	Severe Storms, Flooding and Tornadoes	August 17, 2010 June 12, 2010 to July 31, 2010	Public Assistance
DR-1773	Severe Storms and Flooding	June 25, 2008 June 1, 2008 to August 13, 2008	Individual Assistance and Public Assistance
EM-3281	Severe Winter Storm	December 12, 2007 December 8, 2007 to December 15, 2007	Public Assistance
DR-1673	Severe Winter Storms	December 29, 2006 November 30, 2006 to December 2, 2006	Public Assistance
DR-1635	Severe Storms, Tornadoes and Flooding	April 6, 2006 March 30, 2006 to April 3, 2006	Individual Assistance and Public Assistance
EM-3232	Hurricane Katrina Evacuation	September 10, 2005 August 29, 2005 to October 1, 2005	Public Assistance
DR-1463	Severe Storms, Tornadoes and Flooding	May 6, 2003 May 4, 2003 to May 30, 2003	Individual Assistance and Public Assistance
DR-1412	Severe Storms and Tornadoes	May 6, 2002 April 24 to 2002 to June 10, 2002	Public Assistance
DR-1403	Ice Storm	February 6, 2002 January 29, 2002 to February 13, 2002	Public Assistance

Source: Federal Emergency Management Agency <http://www.fema.gov/disasters>

### 3.1.3 Research Additional Sources

List the additional sources of data on locations and past impacts of hazards in the planning area:

- Missouri State Hazard Mitigation Plans (2010 and 2013)
- Marion County Missouri Natural Hazard Mitigation Plan
- Federal Emergency Management Agency (FEMA)
- Missouri Department of Natural Resources (MDNR)
- National Drought Mitigation Center Drought Reporter
- US Department of Agriculture's (USDA) Risk Management Agency Crop Insurance Statistics
- National Agricultural Statistics Service (Agriculture production/losses)

- 
- Data Collection Questionnaires completed by each jurisdiction
  - State of Missouri GIS data
  - Environmental Protection Agency
  - Flood Insurance Administration
  - Hazards US (HAZUS)
  - Missouri Department of Transportation
  - Missouri Division of Fire Marshal Safety
  - National Fire Incident Reporting System (NFIRS)
  - National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC)
  - County and local Comprehensive Plans to the extent available
  - County Emergency Management
  - County Flood Insurance Rate Map, FEMA
  - Flood Insurance Study, FEMA
  - SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin
  - U.S. Army Corps of Engineers
  - U.S. Department of Transportation
  - United States Geological Survey (USGS)
  - Various articles and publications available on the internet (you should state that you will give citations to the sources in the body of the plan)

The only centralized source of data for many of the weather-related hazards is the National Oceanic and Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC). Although it is usually the best and most current source, there are limitations to the data which should be noted. The NCDC documents the occurrence of storms and other significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce. In addition, it is a partial record of other significant meteorological events, such as record maximum or minimum temperatures or precipitation that occurs in connection with another event. Some information appearing in the NCDC may be provided by or gathered from sources outside the National Weather Service (NWS), such as the media, law enforcement and/or other government agencies, private companies, individuals, etc. An effort is made to use the best available information but because of time and resource constraints, information from these sources may be unverified by the NWS. Those using information from NCDC should be cautious as the NWS does not guarantee the accuracy or validity of the information.

The NCDC damage amounts are estimates received from a variety of sources, including those listed above in the Data Sources section. For damage amounts, the NWS makes a best guess using all available data at the time of the publication. Property and crop damage figures should be considered as a broad estimate. Damages reported are in dollar values as they existed at the time of the storm event. They do not represent current dollar values.

The database currently contains data from January 1950 to March 2014, as entered by the NWS. Due to changes in the data collection and processing procedures over time, there are unique



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periods of record available depending on the event type. The following timelines show the different time spans for each period of unique data collection and processing procedures.

1. Tornado: From 1950 through 1954, only tornado events were recorded.
2. Tornado, Thunderstorm Wind and Hail: From 1955 through 1992, only tornado, thunderstorm wind and hail events were keyed from the paper publications into digital data. From 1993 to 1995, only tornado, thunderstorm wind and hail events have been extracted from the Unformatted Text Files.
3. All Event Types (48 from Directive 10-1605): From 1996 to present, 48 event types are recorded as defined in NWS Directive 10-1605.

Note that injuries and deaths caused by a storm event are reported on an area-wide basis. When reviewing a table resulting from an NCDC search by county, the death or injury listed in connection with that county search did not necessarily occur in that county.

**3.1.4 Hazards Identified**

Because the jurisdictions in Marion County differ in their susceptibilities to certain hazards- for example Hannibal located on the Mississippi River is more likely to experience significant flooding than the City of Palmyra which is not located by any major river. The hazards identified were based on the input from the planning team members, available historical data and the hazard modeling results described within the hazard mitigation plans. The jurisdictions and hazards chosen that significantly impact the planning area is listed in alphabetical order in Table 3.2. The chart includes an “x” to indicate the jurisdiction is impacted by the hazard and a “-” indicates the hazard is not applicable to that jurisdiction.

**Table 3.4 Hazards Identified for Each Jurisdiction**

Jurisdiction	Dam Failure	Drought	Earthquake	Extreme Heat	Wild Fires	Flooding (River and Flash)	Land Subsidence/Sinkholes	Levee Failure	Severe Winter Weather	Thunderstorm/Lightning/Hail/High Wind	Tornado
Marion County	x	x	x	x	x	x	x	x	x	x	x
Hannibal	x	x	x	x	x	x	x	x	x	x	X
Palmyra R-1 School District	x	x	x	x	x	x	x	x	x	x	x

### 3.1.5 Multi-Jurisdictional Risk Assessment

For this multi-jurisdictional plan, the risks are assessed for each jurisdiction where they deviate from the risks facing the entire planning area. The planning area is fairly uniform in terms of climate and topography as well as building construction characteristics. Accordingly, the geographic areas of occurrence for weather-related hazards do not vary greatly across the planning area for most hazards. Hannibal and Palmyra are more urbanized within the planning area and have more assets that are vulnerable to the weather-related hazards and varied development trends impact the future vulnerability. Similarly, more rural areas have more assets (crops/livestocks) that are vulnerable to animal/plant/crop disease. These differences are discussed in greater detail in the vulnerability sections of each hazard.

The hazards that have the potential to vary across the planning area in terms of geographic areas at risk include dam failure, flash flood, grass or wildland fire, levee failure, river flood, flash flood, and sinkholes/land subsidence.

## 3.2 Assets at Risk

This section assesses the population, structures, critical facilities and infrastructure, and other important assets in the planning area that may be at risk to natural hazards. Table 3.3 shows the total population, building county, estimated value of buildings, estimated value of contents and estimated total exposure to parcels by jurisdiction. Please note that for Hannibal this exposure data is only for the portion on the Marion County side. The majority of Hannibal is in Marion County. Therefore, Hannibal is an official participant of this plan.

### 3.2.1 Total Exposure of Population and Structures

#### Unincorporated County and Incorporated Cities

Maximum population, Building Exposure, building values/ exposure by usage type and building contents by usage Information type was not provided by the MPC and was not included in the hazard mitigation plan.

**Table 3.5** The number of enrolled students at the participating public school districts is provided in **Table 3.5** below. Additional information includes the number of buildings, building values (building exposure) and contents value (contents exposure). These numbers will represent the total enrollment and building count for the Palmyra public school districts.

**Table 3.5 Population and Building Exposure by Jurisdiction-Public School Districts**

Public School District	Enrollment	Building Count	Building Exposure (\$)	Contents Exposure (\$)	Total Exposure (\$)
Palmyra R-1 School District	467	8	37,553,616	8,529,007	46,082,623

Source: Data Collection Questionnaire from Public School District. In general, the school district obtain this information from their insurance coverage amounts.

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### 3.2.2 Critical and Essential Facilities and Infrastructure

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This section will include information from the Data Collection Questionnaire and other sources concerning the vulnerability of participating jurisdictions' critical, essential, high potential loss, and transportation/lifeline facilities to identified hazards. Definitions of each of these types of facilities are provided below.

- **Critical Facility:** Those facilities essential in providing utility or direction either during the response to an emergency or during the recovery operation.
- **Essential Facility:** Those facilities that if damaged, would have devastating impacts on disaster response and/or recovery.
- **High Potential Loss Facilities:** Those facilities that would have a high loss or impact on the community.
- **Transportation and lifeline facilities:** Those facilities and infrastructure critical to transportation, communications, and necessary utilities.

**Table 3.6** includes a summary of the inventory of critical and essential facilities and infrastructure in the planning area. The list was compiled from the Data Collection Questionnaire as well as the following sources:

- Mark Twain Regional Council of Governments list of critical facility inventory

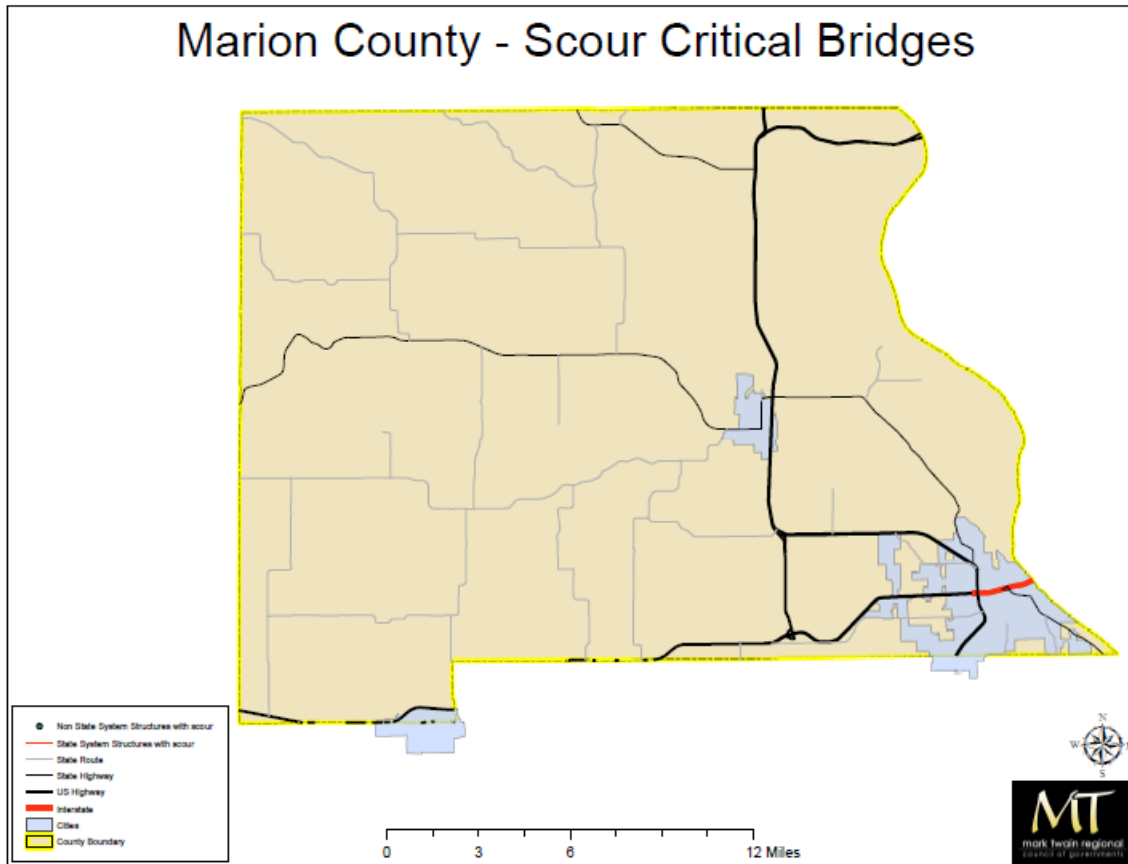
**Table 3.6 Inventory of Critical/Essential Facilities and Infrastructure by Jurisdiction**

Jurisdiction	Airport Facility	Bus Facility	Childcare Facility	Communications Tower	Electric Power Facility	Emergency Operations	Fire Service	Government	Housing	Shelters	Highway Bridge	Hospital/Health Care	Military	Natural Gas Facility	Nursing Homes	Police Station	Potable Water Facility	Rail	Sanitary Pump Stations	School Facilities	Stormwater Pump Stations	Tier II Chemical Facility	Wastewater Facility
Unincorporated Marion				x	x		x		x		x						x	x					x
Hannibal	x		x	x		x	x	x	x	x	x	x	x	x	x	x		x	x	x	x		
<b>Totals</b>	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x

Source: Data Collection Questionnaires;

**Bridges:** This term refers to one of the database elements in the National Bridge Inventory. This element is quantified using a “scour index”, which is a number indicating the vulnerability of a bridge to scour during a flood. Bridges with a scour index between 1 and 3 are considered “scour critical”, or a bridge with a foundation determined to be unstable for the observed or evaluated scour condition. There were no bridges indicated as “scour critical” in the planning area.

**Figure 3.1. Marion County Bridges**



County	Count	# Str Def	# Func Obs	Total Def	Area	Stru Def Area	Func Obs Area	Total Def Area
Marion (127)	188	30	8	38	131,945	15,325	5,077	20,402

Source: [www.fhwa.dot.gov/bridge/nbi/no10/county15b.cfm#mo](http://www.fhwa.dot.gov/bridge/nbi/no10/county15b.cfm#mo)

### 3.2.3 Other Assets

Assessing the vulnerability of the planning area to disaster also requires data on the natural, historic, cultural, and economic assets of the area. This information is important for many reasons.

- These types of resources warrant a greater degree of protection due to their unique and irreplaceable nature and contribution to the overall economy.
- Knowing about these resources in advance allows for consideration immediately following a hazard event, which is when the potential for damages is higher.
- The rules for reconstruction, restoration, rehabilitation, and/or replacement are often different for these types of designated resources.



- The presence of natural resources can reduce the impacts of future natural hazards, such as wetlands and riparian habitats which help absorb floodwaters.
- Losses to economic assets like these (e.g., major employers or primary economic sectors) could have severe impacts on a community and its ability to recover from disaster.

In the planning area, specific assets include the following:

Threatened and Endangered Species: Table 3.7 includes Federally Threatened, Endangered, Proposed and Candidate Species in Marion County, Missouri.

**Table 3.7 Threatened and Endangered Species in Marion County**

Common Name	Scientific Name	Status
Piping Plover	Charadrius melodus	Threatened
Least tern	Sterna antillarum	Endangered
Red Knot	Calidris canutus rufa	Threatened
Higgins Eye	Lampsilis	Endangered
Fat pocketbook	Potamius capax	Endangered
Specaclecase	Cumberlandia monodonta	Endangered
Sheepnose Mussel	Plethobasus cyphuus	Endangered
Indiana bat	Myotis sodalist	Endangered
Gray bat	Myotis grisescens	Endangered
Northern Long-Eared Bat	Myotis septentrionalis	Threatened
Pallid Sturgeon	Scaphirhynchus albus	Endangered

Source: U.S. Fish and Wildlife Service

**Natural Resources:** Marion County has several conservation and recreational areas. The Missouri Department of Conservation (MDC) provides a database of lands the MDC owns, leases, or manages for public use. **Table 3.8** provides the names and location of parks and conservation areas in the planning area owned by the Missouri Department of Conservation. **Table 3.9** provides the names and location of parks in the City of Hannibal and Palmyra.

**Table 3.8 Parks in Unincorporated Marion County**

Area Name	Address	City
Black Hawk Access	County Road 134	Hannibal
Callhan Mound Access	County Road 197	Philadelphia
Dunn Ford Access	County Road 123	Philadelphia
Elmslie Mem CA	County Road 229	Hannibal
Fabius Chute Access	County Road 342	Palmyra
McPike Access	County Road 137	Hannibal
Palmyra (Akerson Access)	Business Highway 61	Palmyra
Ray (J Thad) Mem WA	Route W	Hannibal
Soulard Access	County Road 344	Hannibal
Steyermark (Julian) Woods CA	County Road 410	Hannibal
Sunrise Access	County Road 150	Palmyra
Upper Mississippi CA	Various locations	

<http://mdc4.mdc.mo.gov/applications/moatlas/AreaList.aspx?txtUserID=guest&txtAreaNm=s>

**Table 3.9 Parks in the City of Hannibal and Palmyra**

Park Name	Address	City
Central Park	450 Broadway	Hannibal
Ann Dorsey Hodgdon Park	983 Rock Street	Hannibal
Broadway Mini Park	215 Broadway	Hannibal
Huckleberry Park	1300 30 <sup>th</sup> Street	Hannibal
Nipper Park	100 Broadway	Hannibal
Riverview Park	2000 Harrison Hill	Hannibal
Cardiff Hill Overlook Park	505 N. 3 <sup>rd</sup> Street	Hannibal
Dempsey Dog Park	607 Ely Street	Hannibal
Dulany Park	600 Lemon Street	Hannibal
Glascocock's Landing	100 Hill Street	Hannibal
Kiwanis Park	150 Broadway	Hannibal
Lover's Leap	1100 Birch Street	Hannibal
Norfolk & Southern Mulit Sports Park	621 Warren Barrett Drive	Hannibal
Ringer Park	South Main & Warren Barrett	Hannibal
Soutside Recreation Park	527 Main Street	Hannibal
Spooner Creek Park	301 West Terrace Ave.	Hannibal
West Ely Park	4317 West Ely Road	Hannibal
Willow Street Community Park	404 Willow Street	Hannibal
Flower City Park	Ross Street	Palmyra

Source: City Website

**Historic Resources:** The National Register of Historic Places is the official list of registered cultural resources worthy of preservation. It was authorized under the National Historic Preservation Act of 1966 as part of a national program. The purpose of the program is to coordinate and support public and private efforts to identify, evaluate, and protect our historic and archeological resources. The National Register is administered by the National Park Service under the Secretary of the Interior. Properties listed in the National Register include districts, sites, buildings, structures and objects that are significant in American history, architecture, archeology, engineering, and culture.

**Table 3.10 Marion County Properties on the National Register of Historic Places**

Property	Address	City	Date Listed
Barkley, Levi House		Hannibal	3/2/1984
Broadway District	S. Main, Broadway and S. Third Street	Hannibal	8/01/1986
Buildings at 207 – 209 S. Main Street	207-209 S. Main Street	Hannibal	8/01/1986
Central Park District	4 <sup>th</sup> , 7 <sup>th</sup> , North & Lyon Streets	Hannibal	10/07/1982
Clemens Field	401 Collier	Hannibal	8/26/2008
Culbertson-Head Farmstead	7178 County Road 402	Palmyra	9/04/2008
Davidisson Building	106 S. Main	Hannibal	8/01/1986
Digel Block	218-222 S. Main Street	Hannibal	8/01/1986
Dryden-Louthan House	402 E. Ross	Palmyra	1/18/1985
Ebert-Dulany House	1000 Center Street	Hannibal	2/17/1983
Eighth and Center Streets Baptist Church	722 Center Street	Hannibal	9/04/1980
Elliott's Robert, Wholesale Grocery	116-120 S. Third	Hannibal	8/01/1986
Federal Building	600 Broadway	Hannibal	10/15/1980
Gardner House	421 Hamilton and Main Street	Palmyra	3/04/1971
Green Double House	113-115 S. Third Street	Hannibal	8/01/1986
Hafner Grocery Warehouse	101 East Church Street	Hannibal	8/01/1986
Hannibal Lime Company Office	623 Collier Street	Hannibal	9/06/1984
Hannibal Old Police Station and Jail	4 <sup>th</sup> and Church Streets	Hannibal	7/17/1979

Hendren Farm	Off US Highway 61	Hannibal	8/22/1984
Hock Building	312 Center Street	Hannibal	12/02/1986
Holmes-akin Building	120-122 S Main Street	Hannibal	8/01/1986
Benjamin Horr House	308 Central Street	Hannibal	12/02/1986
Maple Avenue Historic District	Broadway & Center Street	Hannibal	11/21/2002
Marion County Courthouse	906 Broadway	Hannibal	10/22/2002
Marion County Jail & Jailors House	210 W. Lafayette Street	Palmyra	10/04/2002
Mark Twain Historic District	Bird, Main & Hill Streets	Hannibal	1/04/1978
Mark Twain Hotel	200 S. Main	Hannibal	8/01/1986
Robert Masterson House	NW of Hannibal	Hannibal	4/05/1984
North Main Street Historic District	Bird, N. Main and Hill Streets	Hannibal	8/01/1986
Osterhout Mound Park	Wauneta Place	Hannibal	4/11/1973
Riverview Park	2000 Harrison Hill	Hannibal	9/06/2005
Rockcliffe Mansion	1000 Bird Street	Hannibal	9/18/1980
St. Elizabeth Hospital	109 Virginia Street	Hannibal	8/14/2012
Sharkey Mound Group	Address Restricted		12/18/1973
Peter J. Sowers House	221 Home Street	Palmyra	1/18/1985
Speigle House	406 S. Dickerson	Palmyra	2/14/1985
Standard Printing Company	210 N. Third Street	Hannibal	8/01/1986
Mark Twain Boyhood Home	206-208 Hill Street	Hannibal	10/15/1966
Walker-Woodward-Schaffer House	1425 S. Main Street	Palmyra	2/16/1984
Ephriam J. Wilson Farm Complex	E. of Palmyra off MO 168	Palmyra	12/28/1982

Source: Missouri Department of Natural Resources – Missouri National Register Listings by County  
<http://dnr.mo.gov/shpo/mnrlist.htm>

Economic Resources: Major employers in the planning area include following:

**Table 3.11 Major Non-Government Employers in Marion County**

Employer Name	Main Locations	Product or Service	Employees
General Mills	Hannibal	Food Manufacturing	980
Hannibal Regional Hospital	Hannibal	General Medical	913
Hannibal School District	Hannibal	Education	576
BASF Corp	Palmyra	Nitrogenous Fertilizer	449
MoDOT	Hannibal	Transportation	441
Wal-Mart Supercenter	Hannibal	Retail	375
Watlow	Hannibal	Electric Heating Elements	350
Chester Bross Construction	Hannibal	Construction	350
Swiss Colony Data Center	Hannibal	Sales Center	350
Hannibal Clinic	Hannibal	Healthcare	350
Printex	Hannibal	Textile Manufacturer	270

Beth Haven	Hannibal	Retirement Community	255
Hannibal LaGrange Univ.	Hannibal	Higher Education	250
Continental Cement	Hannibal	Cement Manufacturer	230
Levering Regional Healthcare	Hannibal	Healthcare	215
Buckhorn Rubber	Hannibal	Rubber Product Manufacturing	200
Bleigh Construction	Hannibal	Construction	196
Lowe's Home Improvement	Hannibal	Retail	120

Source: Data Collection Questionnaires; local Economic Development Commissions

### Agriculture

Agriculture plays a major role in the Marion County economy and one of the major employers is a supplier to the agriculture economy.

	2012	2007	% change
Number of farms	704	749	+6
Land in Farms	221,469 acres	237,016 acres	
+7			
Average Size of Farm	315	316	
+ .32			
Market Value of Products Sold	\$87,121,000	\$76,526,000	
-12			
Crop Sales	\$53,674,000 (61%)	\$49,252,000 (64%)	
Livestock Sales	\$33,447,000 (38%)	\$27,274,000 (36%)	
Average Per Farm	\$123,757	\$102,172	-17
Government Payments	\$3,060,000	\$3,030,000	
-.98			
Average Per Farm Receiving Payments	\$6,108	\$5,372	
-12			

### 3.3 Future Land Use and Development

Population data can sometimes be used to determine the potential for future development. An increase in population will spur a need for additional housing and attract commercial development. As indicated by the information in Table 3.12, Marion County has experienced a decline in population.

**Table 3.12 Marion County Population Growth, 2000-2010**

Jurisdiction	Total Population 2010	Total population 2000	2000-2010 # Change	2000-2010 % Change
Marion County	28,781	28,289	-492	1.7%
Hannibal	17,916	17,659	-257	1.4%

Source: U.S. Bureau of the Census, Decennial Census; Population Statistics are for entire incorporated areas as reported by the Census bureau

Along with the population decline there has been a decline in the number of housing units except for the city of Hannibal. Table 3.14 provides the change in number of housing units in the planning area from 2000 to 2010.

**Table 3.13 Change in Housing Units, 2000-2010**

Jurisdiction	Housing Units 2010	Housing Units 2000	2000-2010 # Change	2000-2010 % change
Marion County	12,826	12,443	383	3%
Hannibal	8,021	7,886	135	1.7%

Source: U.S. Bureau of the Census, Decennial Census; Population Statistics are for entire incorporated areas as reported by the U.S. Census Bureau

Population growth or decline is generally accompanied by increases or decreases in the number of housing units. With the trend of population increase for the entire county there is reason to expect increased development.

#### ***School District's Future Development***

The school districts in the planning area have indicated there are no plans of expansion within the next five years.

#### ***School District's Future Development***

Moberly Area Community College is investing significantly in Marion County by constructing a new campus within the city limits of Hannibal.

## 3.4 Hazard Profiles, Vulnerability, and Problem Statements

Each hazard will be analyzed individually in a hazard profile. The profile will consist of a general hazard description, location, severity/magnitude/extent, previous events, future probability, a discussion of risk variations between jurisdictions, and how anticipated development could impact risk. At the end of each hazard profile will be a vulnerability assessment, followed by a summary problem statement.

### Hazard Profiles

**Requirement §201.6(c)(2)(i): [The risk assessment shall include a] description of the...location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.**

Each hazard identified in Section 3.1.4 is profiled individually in this section. The level of information presented in the profiles will vary by hazard based on the information available. With each update of this plan, new information will be incorporated to provide better evaluation and prioritization of the hazards that affect the planning area. Detailed profiles for each of the identified hazards include information categorized as follows:

**Hazard Description:** *This section consists of a general description of the hazard and the types of impacts it may have on a community or school/special district.*

**Geographic Location:** *This section describes the geographic location of the hazard in the planning area. Where available, maps are utilized to indicate the specific locations of the planning area that are vulnerable to the subject hazard.*

**Severity/Magnitude/Extent:** *This section includes information about the severity, magnitude, and extent of a hazard. The entire planning area is at risk for some hazards. For some hazards, this is accomplished with description of a value on an established scientific scale or measurement system, such as an EF2 tornado on the Enhanced Fujita Scale. Severity, magnitude, and extent can also include the speed of onset and the duration of hazard events. Describing the severity/magnitude/extent of a hazard is not the same as describing its potential impacts on a community. Severity/magnitude/extent defines the characteristics of the hazard regardless of the people and property it affects.*

**Previous Occurrences:** *This section includes available information on historic incidents and their impacts. Historic event records form a solid basis for probability calculations.*

**Probability of Future Occurrence:** *The frequency of recorded past events is used to estimate the likelihood of future occurrences. Probability was determined by dividing the number of recorded events by the number of years and multiplying by 100. This gives the percent chance of the event happening in any given year. For events occurring more than once annually, the probability will be reported 100% in any given year, with a statement of the average number of events annually.*



## Vulnerability Assessments

**Requirement §201.6(c)(2)(ii) :**[The risk assessment shall include a] description of the jurisdiction’s vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.

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

**Requirement §201.6(c)(2)(ii)(B) :**[The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate.

**Requirement §201.6(c)(2)(ii)(C) :**[The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

**Requirement §201.6(c)(2)(ii): (As of October 1, 2008) [The risk assessment] must also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged in floods.**

Following the hazard profile for each hazard will be the vulnerability assessment. The vulnerability assessment further defines and quantifies populations, buildings, critical facilities, and other community assets at risk to damages from natural hazards. The vulnerability assessments will be based on the best available county-level data, which is in the Missouri State Hazard Mitigation Plan (2010). The county-level assessments in the State Plan were based on the following sources:

- Statewide GIS data sets compiled by state and federal agencies; and
- FEMA’s HAZUS-MH loss estimation software.

The vulnerability assessments in the Marion County plan will also be based on:

- Written descriptions of assets and risks provided by participating jurisdictions;
- Existing plans and reports;
- Personal interviews with planning committee members and other stakeholders; and
- Other sources as cited.

## Vulnerability Overview

This section consists of a general overview narrative of the planning area’s vulnerability to the hazard. Within this section, the magnitude/severity of the hazard is discussed. The magnitude of the impact of a hazard event (past and perceived) is related directly to the vulnerability of the people, property, and the environment it affects. This is a function of when the event occurs, the location affected by the resilience of the community, and the effectiveness of the emergency response and

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disaster recovery efforts.

**Potential Losses to Existing Development:** This section provides the potential losses existing development.

**Future Development:** This section will include information on anticipated future development in the county, and how that would impact hazard risk in the planning area.

**Hazard Summary by Jurisdiction:** For hazard risks that vary by jurisdiction, this section will provide an overview of the variation and the factual basis for that variation.

### **Problem Statements**

Each hazard analysis will conclude with a brief summary of the problems created by the hazard in the planning area, and possible ways to resolve those problems. If the risk varies across the planning area jurisdiction-specific information will be included.

### 3.4.1 Dam Failure

#### Hazard Profile

#### Hazard Description

A dam is defined as a barrier constructed across a watercourse for the purpose of storage, control, or diversion of water. Dams are typically constructed of earth, rock, concrete, or mine tailings. Dam failure is the uncontrolled release of impounded water resulting in downstream flooding, affecting both life and property. Dam failure can be caused by any of the following:

1. Overtopping - inadequate spillway design, debris blockage of spillways or settlement of the dam crest.
2. Piping: internal erosion caused by embankment leakage, foundation leakage and deterioration of pertinent structures appended to the dam.
3. Erosion: inadequate spillway capacity causing overtopping of the dam, flow erosion, and inadequate slope protection.
4. Structural Failure: caused by an earthquake, slope instability or faulty construction.

Data on Dams in Marion County has been drawn from two sources; a listing maintained by the Missouri Department of Natural Resources (MoDNR) and the Army Corps of Engineers' National Dam Inventory (NID). Each has its own system of classifying dams. For the purpose of planning, the NID information was used. Neither the MoDNR nor the NID hazard potential classification references the condition of the dam.

**Table 3.14 MDNR Dam Hazard Classification Definitions**

Hazard Class	Definition
Class I	Contains 10 or more permanent dwellings or any public building
Class II	Contains 1 to 9 permanent dwellings or 1 or more campgrounds with permanent water, sewer, and electrical services or 1 or more industrial buildings
Class III	Everything else

Source: Missouri Department of Natural Resources, [http://dnr.mo.gov/env/wrc/docs/rules\\_reg\\_94.pdf](http://dnr.mo.gov/env/wrc/docs/rules_reg_94.pdf)

**Table 3.15 NID Dam Hazard Classification Definitions**

Hazard Class	Definition
Low Hazard	A dam located in an area where failure could damage only farm or other uninhabited buildings, agricultural or undeveloped land including hiking trails, or traffic on low volume roads that meet the requirements for low hazard dams
Significant Hazard	A dam located in an area where failure could endanger a few lives, damage an isolated home, damage traffic on moderate volume roads that meet certain requirements, damage low-volume railroad tracks, interrupt the use or service of a utility serving a small number of customers, or inundate recreation facilities, including campground areas intermittently used for sleeping and serving a relatively small number of person

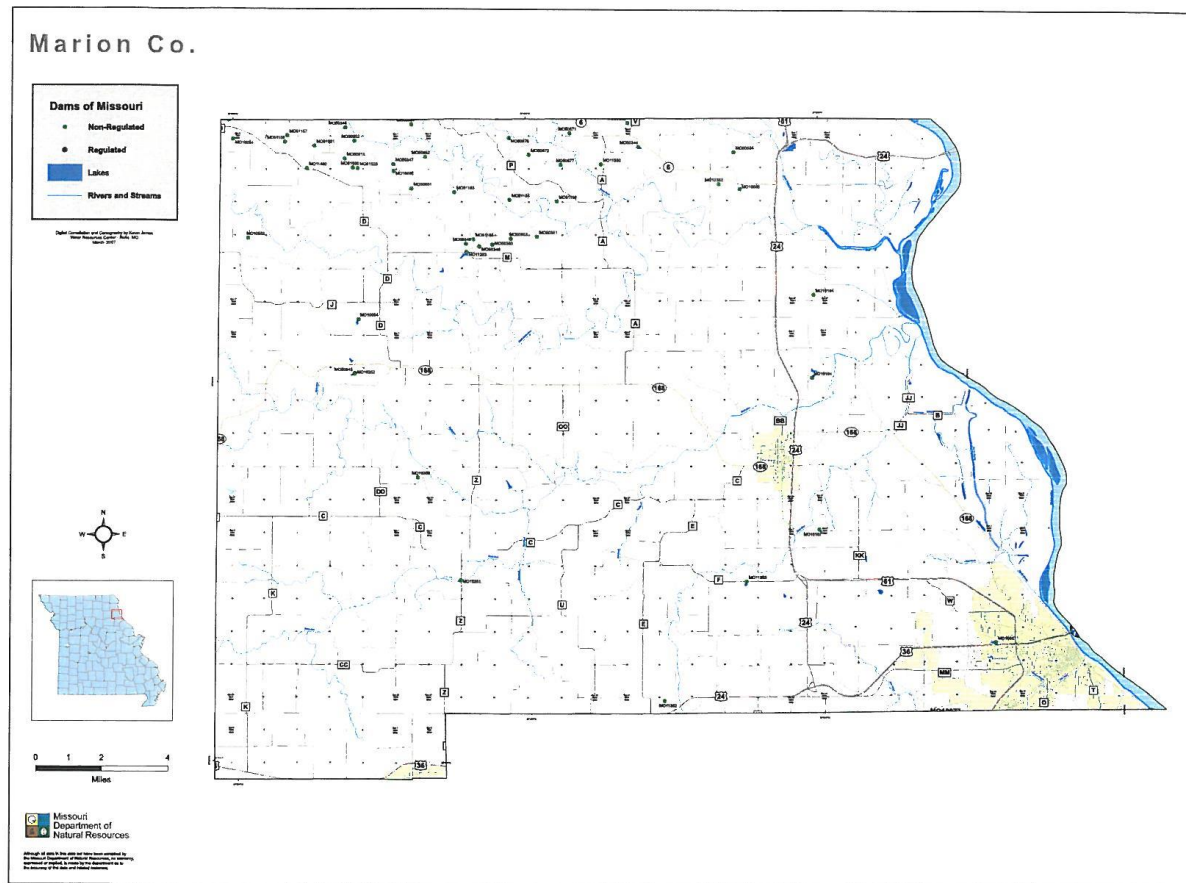
High Hazard

A dam located in an area where failure could result in any of the following: extensive loss of life, damage to more than one home, damage to industrial or commercial facilities, interruption of a public utility serving a large number of customers, damage to traffic on high-volume roads that meet the requirements for hazard class C dams or a high-volume railroad line, inundation of a frequently used recreation facility serving a relatively large number of persons, or two or more individual hazards described for significant hazard dams

Source: National Inventory of Dams

## Geographic Location

Figure 3.2 Dams in Planning Area



Marion County has no state-regulated dams inside the county boundaries. Within the State of Missouri, the Department of Natural Resources maintains a Dam and Safety Program overseen by the Division of Geology and Land Survey. Chapter 236 Revised Statutes of Missouri state that a dam must be 35 feet or higher to be state regulated. The United States Army Corps of Engineers regulates the Lock and Dam #21 on the Mississippi River.

The NID Dam data for Marion County includes the following 47 dams: Frankenbach Brothers Lake, Sutter Dam, Stevens Lake Dam, Russel Sandifer Dam, Tallent Lake Dam, Gentry Dam, Lavingon Dam, Sparrow Lake Dam, Bridgeman Dam, Well Dr. JW Dam, Keller Lake Dam, Disckson Lake Dam, Mononame 12, Gard Lake Dam, Gottman Dam, Bevill Dam, Moser Dam, Bevill Dam, Lesser Lake Dam, Troublesome Creek Watershed Dams – 96, 31, 43, 37, 32, 91, 92, 35, 42, 40, 97, 28, 95, 38,

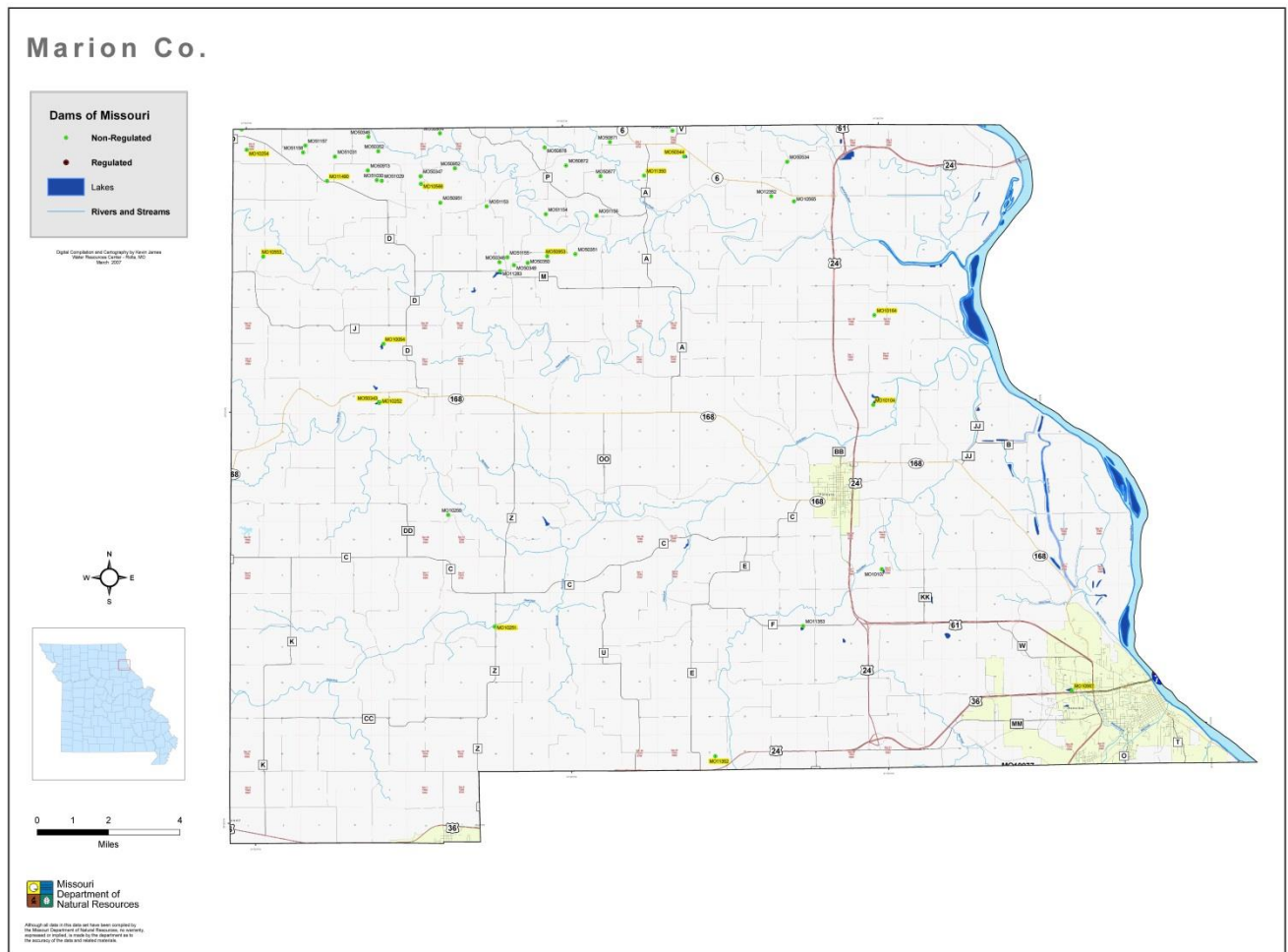
39, 26, 29, 94, 98, 93, 41, Grassy Creek Watershed Dams-99, 93, 94, Reid Dam and Bimson Dam.

**Table 3.16 High Hazard Dams in the Marion County Planning Area**

Dam Name	Other Dam Name	NID#	Hazard Potential *	NID Height (ft.)	River	Nearest City *	Distance To City (Mi.) *	County	State
FRANKENBACH BROS LAKE DAM	-	MO11353	High	30	TR-SOUTH RIVER	HANNIBAL	23	MARION	MO
SUTTER DAM	-	MO11283	High	27	TR TROUBLESOME CREEK	EMERSON	-	MARION	MO
STEVENS LAKE DAM	-	MO10107	High	36	TR SOUTH RIVER	HANNIBAL	20	MARION	MO
RUSSEL SANDIFER DAM	-	MO10259	High	28	TR-NORTH RIVER	PALMYRA	10	MARION	MO
TALLENT LAKE DAM	-	MO10553	Low	25	TR-SOUTH FABIVS RIVER	EMERSON	7	MARION	MO
GENTRY DAM	-	MO11352	Low	24	TR SOUTH RIVER	WEST ELY	3	MARION	MO
LAVINGON DAM	-	MO11350	Low	26	TR GRASSY CREEK	HANNIBAL	28	MARION	MO
SPARROW LAKE DAM	-	MO11489	Low	25	TR-ALLEN BRANCH	NELSONVILLE	4	MARION	MO
BRIDGMAN DAM	-	MO11490	Low	25	TR-SOUTH FABIVS RIVER	NELSONVILLE	35	MARION	MO
WELL,DR J W DAM	DR JW WELL DAM -1974 DAM INV	MO10054	Low	20	TR SOUTH FABIVS RIVER	PHILADELPHIA	2	MARION	MO
KELLER LAKE DAM	CB KELLER DAM - 1974 DAM INV	MO10565	Low	29	TR-SOUTH FABIVS RIVER	HANNIBAL	20	MARION	MO
DICKSON LAKE DAM	-	MO10254	Low	25	TR SOUTH FABIVS RIVER	NELSONVILLE	3	MARION	MO
MONONAME 12	-	MO10164	Low	20	TR NORTH RIVER	WEST QUINCY	-	MARION	MO
GARD LAKE DAM	-	MO10104	Low	10	TR-NORTH RIVER	HANNIBAL	20	MARION	MO
GOTTMAN DAM	-	MO10251	Low	30	TR-SOUTH FORK NORTH RIVER	HANNIBAL	30	MARION	MO
BEVILL DAM	-	MO10252	Low	25	TR NORTH RIVER	PHILADELPHIA	1	MARION	MO
TROUBLESOME CREEK WATERSHED DAM S- 96	STR S-96	MO50352	Low	26	TR-TROUBLESOME CREEK	NELSONVILLE	2	MARION	MO
MOSER DAM	-	MO50534	Low	27	TR-NORTH FABIVS RIVER	TSYLOR	2	MARION	MO
BEVILL DAM	-	MO50343	Low	26	TR-NORTH RIVER	HANNIBAL	27	MARION	MO
LEESER LAKE DAM	-	MO12352	Low	29	TRIB SO FARIUS CREEK	HANNIBAL	25	MARION	MO
TROUBLESOME CREEK WATERSHED DAM R- 31	-	MO50951	Low	28	TROUBLESOME CREEK	NONE	-	MARION	MO
GRASSY CREEK WATERSHED DAM G- 96	-	MO50877	Low	31	GRASSY CREEK	DURHAM	4	MARION	MO
TROUBLESOME CREEK WATERSHED DAM R- 43	-	MO51156	Low	26	TR-TROUBLESOME CREEK	EMERSON	1.5	MARION	MO
TROUBLESOME CREEK WATERSHED DAM R- 37	-	MO51155	Low	30	TR-TROUBLESOME CREEK	PHILADELPHIA	3.5	MARION	MO
TROUBLESOME CREEK WATERSHED DAM R- 32	-	MO51153	Low	31	TR-TROUBLESOME CREEK	EMERSON	2	MARION	MO
TROUBLESOME CREEK WATERSHED DAM S- 91	-	MO51157	Low	27	TR-TROUBLESOME CREEK	STEFFENVILLE	4.5	MARION	MO
TROUBLESOME CREEK WATERSHED DAM S- 92	-	MO51158	Low	31	TR-TROUBLESOME CREEK	STEFFENVILLE	4.5	MARION	MO
TROUBLESOME CREEK WATERSHED DAM R- 35	-	MO51154	Low	27	TR-TROUBLESOME CREEK	EMERSON	1.4	MARION	MO
TROUBLESOME CREEK WATERSHED DAM R- 42	STR R-42	MO50351	Low	25	TR-TROUBLESOME CREEK	NONE	-	MARION	MO
TROUBLESOME CREEK WATERSHED DAM R- 40	STR R-40	MO50350	Low	33	TR-TROUBLESOME CREEK	NONE	-	MARION	MO
TROUBLESOME CREEK WATERSHED DAM S- 97	-	MO51030	Low	38	TR-TROUBLESOME CREEK	NAOMI	5	MARION	MO
TROUBLESOME CREEK WATERSHED DAM R- 28	STR R-28	MO50347	Low	27	TR-TROUBLESOME CREEK	NONE	-	MARION	MO
TROUBLESOME CREEK WATERSHED DAM S- 95	STR S-95	MO50346	Low	26	TR-TROUBLESOME CREEK	NELSONVILLE	2	MARION	MO
TROUBLESOME CREEK WATERSHED DAM R- 38	STR R-38	MO50348	Low	28	TR-TROUBLESOME CREEK	NONE	-	MARION	MO
TROUBLESOME CREEK WATERSHED DAM R- 39	STR R-39	MO50349	Low	32	TR-TROUBLESOME CREEK	NONE	-	MARION	MO
TROUBLESOME CREEK WATERSHED DAM R- 26	-	MO50954	Low	34	TROUBLESOME CREEK	NONE	-	MARION	MO
TROUBLESOME CREEK WATERSHED DAM R- 29	-	MO50952	Low	34	TR-TROUBLESOME	NONE	-	MARION	MO
GRASSY CREEK WATERSHED DAM G- 99	-	MO50871	Low	27	GRASSY CREEK	DURHAM	2.5	MARION	MO
REID DAM	-	MO50628	Low	36	TR-MIDDLE FABIVS RIVER	MAYWOOD	1	MARION	MO
GRASSY CREEK WATERSHED DAM G- 93	-	MO50878	Low	34	GRASSY CREEK	DURHAM	-	MARION	MO
TROUBLESOME CREEK WATERSHED DAM S- 94	-	MO50913	Low	41	TROUBLESOME CREEK	EWING	8	MARION	MO
BIMSON DAM	-	MO50344	Low	26	TR-SOUTH FABIVS RIVER	HANNIBAL	27	MARION	MO
TROUBLESOME CREEK WATERSHED DAM S- 98	-	MO51029	Low	36	TR-TROUBLESOME CREEK	NAOMI	5	MARION	MO
GRASSY CREEK WATERSHED DAM G- 94	-	MO50872	Low	34	GRASSY CREEK	DURHAM	3	MARION	MO
TROUBLESOME CREEK WATERSHED DAM S- 93	-	MO51031	Low	29	TR-TROUBLESOME CREEK	NONE	-	MARION	MO
TROUBLESOME CREEK WATERSHED DAM R- 41	-	MO50953	Significant	37	TR-TROUBLESOME	EMERSON	-	MARION	MO

Sources: National Inventory of Dams, [http://nid.usace.army.mil/cm\\_apex/f?p=838:12](http://nid.usace.army.mil/cm_apex/f?p=838:12)

Figure 3.3 High Hazard Dam Locations in Marion County



Source: U.S. Army Corps of Engineers, Missouri Department of Natural Resources

### Upstream Dams Outside the Planning Area

The Missouri Department of Natural Resources was consulted and Lewis County north of Marion County has four dams: Deerridge, Ewing Lake Dame, LaBelle and Bellview Lake Dam. None of the dams listed would affect Marion County. At the time of plan development, an inundation map was under development. However, it was not yet available for incorporation in the risk assessment. If this, or other inundation maps become available, they will be incorporated in the update to this plan.

### Severity/Magnitude/Extent

The severity/magnitude of dam failure would be similar in some cases to the impacts associated with flood events (see the flood hazard vulnerability analysis and discussion). Based on the hazard class definitions, failure of any of the High Hazard/Class I dams could result in a serious threat of loss of human life, serious damage to residential, industrial or commercial areas, public utilities, public buildings, or major transportation facilities. Catastrophic failure of any high hazard dams has the potential to result in greater destruction due to the potential speed of onset and greater depth, extent, and velocity of flooding. Note that for this reason, dam failures could flood areas outside of mapped flood hazards.

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## Previous Occurrences

To determine previous occurrences of dam failure within the Marion County, the Marion County Missouri Natural Hazard Mitigation Plan was consulted as well as the Missouri State Hazard Mitigation Plan and the Stanford University's National Performance of Dams Program (<http://npdp.stanford.edu/>). No record of dam failure within Marion County boundaries was found.

## Probability of Future Occurrence

Due to the number of high hazard dams (17 in Marion County) dam failure and its associated impacts is a possibility for disaster. Sixteen of the 17 dams are located in rural areas and would not have a major affect. The McKay Dam located within the limits of Hannibal could have a significant impact on the businesses and residents in the inundation area.

## Vulnerability

### Vulnerability Overview

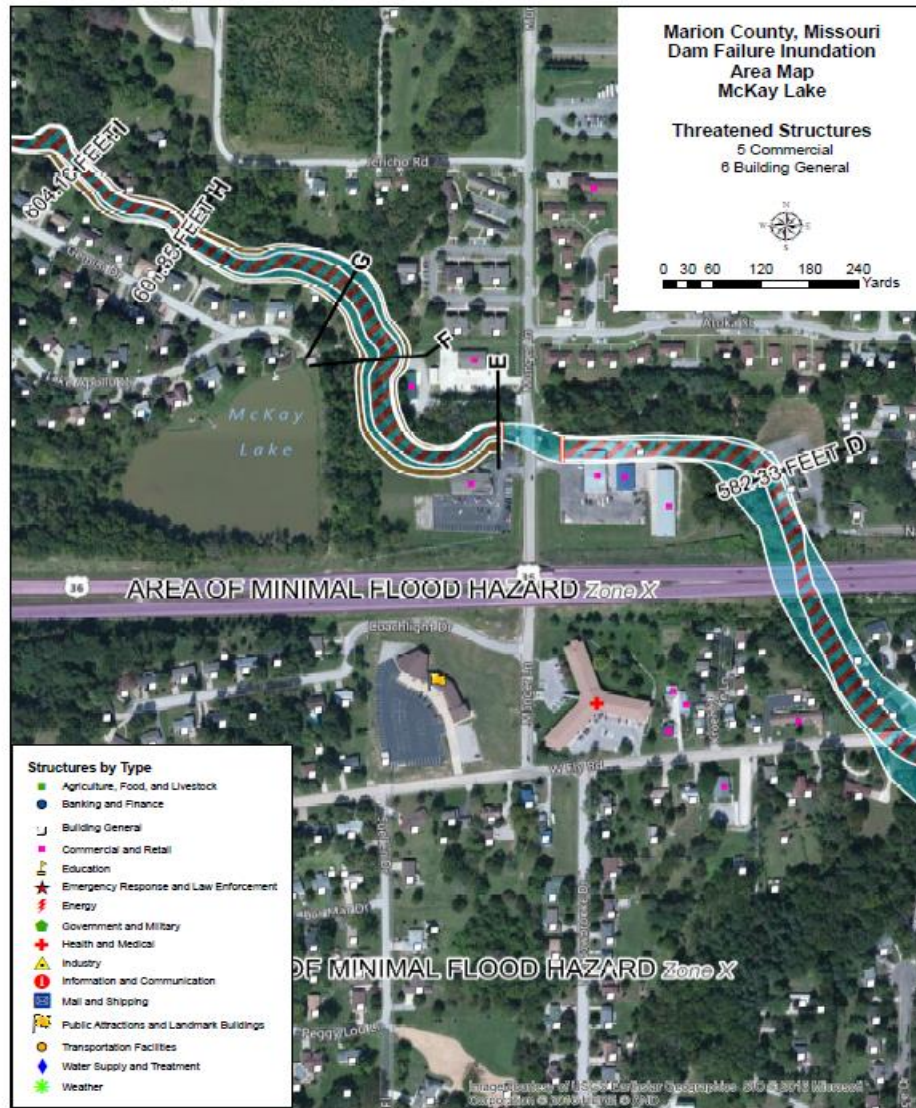
Vulnerability to dam failure is limited to a very few areas in Marion County, primarily within the city of Hannibal where one of the high hazard dams are located.

### Potential Losses to Existing Development: (including types and numbers, of buildings, critical facilities, etc.)

Figure 3.4 shows the lost to existing development if the McKay Dam would fail. The existing development impacted includes business, residential, roadways, and would be catastrophic for the city of Hannibal.



Figure 3.4 McKay Lake Dam



### ***Impact of Future Development***

Future development in the City of Hannibal could impact the amount of damages caused by a failure in the McKay Dam. The location of the 16 remaining high hazard dams in the planning are located in the rural area and future development would have very little impact.

### ***Hazard Summary by Jurisdiction***

Vulnerability to dam failure is very minimal with the exception to the City of Hannibal. The remaining participating jurisdictions including school districts would be affected very minimally.

### **Problem Statement**

Marion County residents with a dam on their property do not properly inspect the dams to ensure the safety of the dam not failing. Residents need to be informed of the proper way to inspect a dam and look for initial problems.

## 3.4.2 Drought

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### Hazard Profile

#### Hazard Description

Drought is generally defined as a condition of moisture levels significantly below normal for an extended period of time over a large area that adversely affects plants, animal life, and humans. A drought period can last for months, years, or even decades. There are four types of drought conditions relevant to Missouri, according to the State Plan, which are as follows:

- Meteorological drought is defined in terms of the basis of the degree of dryness (in comparison to some “normal” or average amount) and the duration of the dry period. A meteorological drought must be considered as region-specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region.
- Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (e.g., streamflow, reservoir and lake levels, ground water). The frequency and severity of hydrological drought is often defined on a watershed or river basin scale. Although all droughts originate with a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system. Hydrological droughts are usually out of phase with or lag the occurrence of meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the hydrological system such as soil moisture, streamflow, and ground water and reservoir levels. As a result, these impacts also are out of phase with impacts in other economic sectors.
- Agricultural drought focus is on soil moisture deficiencies, differences between actual and potential evaporation, reduced ground water or reservoir levels, etc. Plant demand for water depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil.
- Socioeconomic drought refers to when physical water shortage begins to affect people.

Data sources: <http://www.drought.unl.edu/> <http://droughtreporter.unl.edu/>

#### Geographic Location

Droughts are regional in nature. All areas of the United States are vulnerable to the risk of drought and extreme heat. Droughts can be widespread or localized events. The extent of the droughts varies both in terms of the extent of the heat and range of precipitation. The severity of a drought depends on locations, duration, and geographical extent. Additionally drought severity depends on the water supply, usage demands made by human activities, vegetation and agricultural operations. Drought brings several different problems that must be addressed. The quality and quantity of crops, livestock, and other agricultural assets will be affected during a drought. Drought can adversely impact forested areas leading to an increased potential for extremely destructive forest and woodland fires that could threaten residential, commercial, and recreational structures.

As of 2012, 72% of Marion County consisted of land in farms which left 85,091 acres of developed land. Farming is concentrated in the western and southern areas of the county leaving the Eastern part of the county as the most developed.

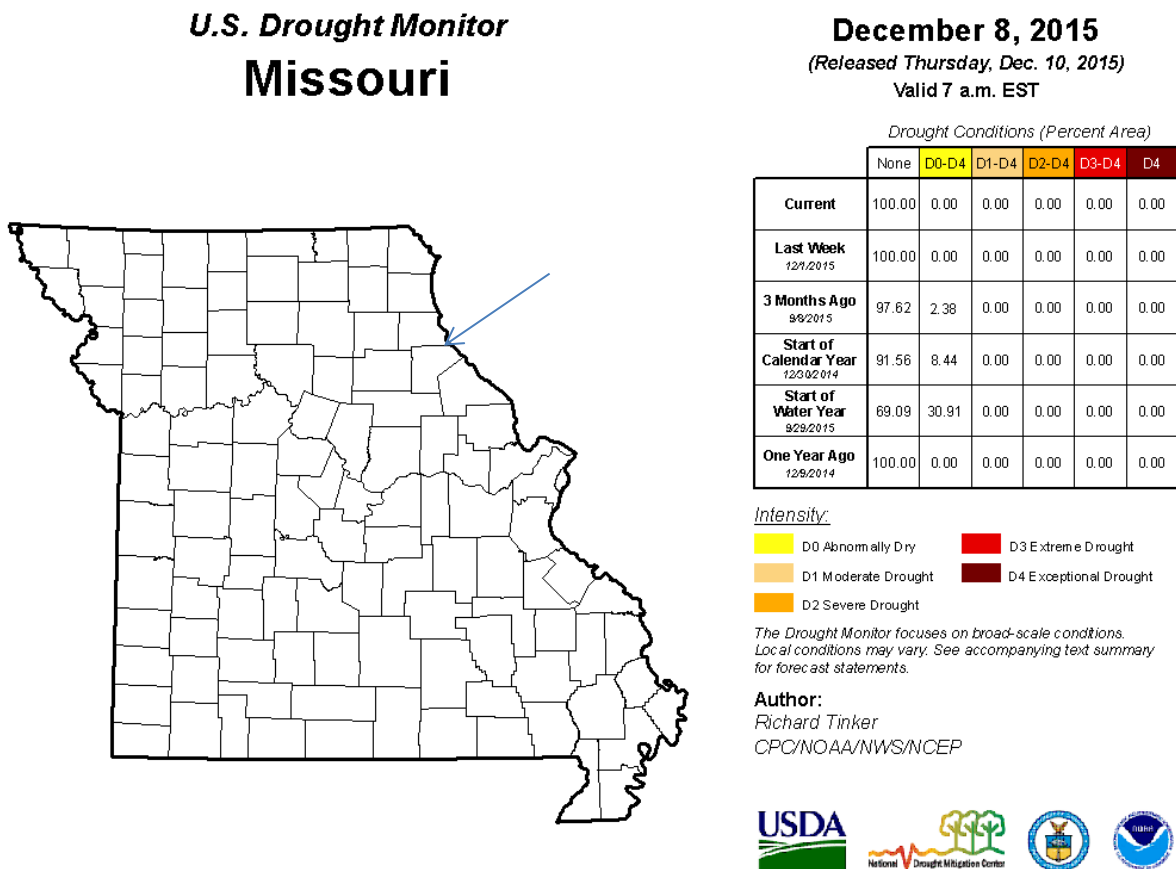
Source:

[http://www.agcensus.usda.gov/Publications/2012/Full\\_Report/Volume\\_1,\\_Chapter\\_2\\_County\\_Level/Missouri/](http://www.agcensus.usda.gov/Publications/2012/Full_Report/Volume_1,_Chapter_2_County_Level/Missouri/)

**Severity/Magnitude/Extent**

The National Drought Monitor Center at the University of Nebraska at Lincoln summarized the potential severity of drought as follows. Drought can create economic impacts on agriculture and related sectors, including forestry and fisheries, because of the reliance of these sectors on surface and subsurface water supplies. In addition to losses in yields in crop and livestock production, drought is associated with increases in insect infestations, plant disease, and wind erosion. Droughts also bring increased problems with insects and disease to forests and reduce growth. The incidence of forest and range fires increases substantially during extended droughts, which in turn place both human and wildlife populations at higher levels of risk. Income loss is another indicator used in assessing the impacts of drought because so many sectors are affected. Finally, while drought is rarely a direct cause of death, the associated heat, dust and stress can all contribute to increased mortality.

**Figure 3.5 U.S. Drought Monitor Map of Missouri on December 14, 2015**



Source: U.S. Drought Monitor, <http://droughtmonitor.unl.edu/Home/StateDroughtMonitor.aspx?MO>

The Palmer Drought Indices measure dryness based on recent precipitation and temperature. The indices are based on a “supply-and-demand model” of soil moisture. Calculation of supply is relatively straightforward, using temperature and the amount of moisture in the soil. However demand is more complicated as it depends on a variety of factors, such as evapotranspiration and recharge rates. These rates are harder to calculate. Palmer tried to overcome these difficulties by developing an algorithm that approximated these rates, and based the algorithm on the most readily available data — precipitation and temperature.

The Palmer Index has proven most effective in identifying long-term drought of more than several months. However, the Palmer Index has been less effective in determining conditions over a matter of weeks. It uses a “0” as normal, and drought is shown in terms of negative numbers; for example, negative 2 is moderate drought, negative 3 is severe drought, and negative 4 is extreme drought. Palmer’s algorithm also is used to describe wet spells, using corresponding positive numbers.

Palmer also developed a formula for standardizing drought calculations for each individual location based on the variability of precipitation and temperature at that location. The Palmer index can therefore be applied to any site for which sufficient precipitation and temperature data is available.

The participating communities use water from a water source other than a well. The communities may face difficulties during a drought that will not be as severe as a community utilizing only well water.

**Table 3.17. USDA Risk Management Insurance Payments Due to Drought in Marion County, 1996-Present**

Year	Indemnity Amount	Year	Indemnity Amount
2015	\$ 58,816.50	2005	\$ 2,916,916.00
2014	\$ -	2004	\$ -
2013	\$ 4,166,306.34	2003	\$ 484,933.00
2012	\$ 18,185,116.45	2002	\$ 572,963.00
2011	\$ 1,401,638.20	2001	\$ 267,628.00
2010	\$ -	2000	\$ 78,026.00
2009	\$ -	1999	\$ 1,867,130.00
2008	\$ -	1998	\$ 154,930.00
2007	\$ 101,437.00	1997	\$ 125,664.00
2006	\$ 95,350.00	1996	\$ 14,708.00

Source: U.S. Risk Management Agency, <http://www.rma.usda.gov/data/cause.html>

## Previous Occurrences

Drought occurs periodically in Missouri with the most severe in historical times occurring in 2012. Other major droughts, usually characterized by deficient rainfall combined with unusually high summer temperatures, occurred in 2013, 2005, and 1999. Although droughts are not the spectacular weather events that floods, blizzards or tornadoes can be, historically they produce more economic damage to the State than all other weather events combined.

According to the National Drought Mitigation Center's Drought Impact Reporter, during the 10-year period from January 2006 to December 2015, Marion County had 221 reported drought impacts. The following are the categories and reported number of impacts:

- Agriculture - 146
- Business & Industry - 37
- Energy - 1
- Fire – 6
- Plants & Wildlife - 15
- Relief, Response, & Restrictions - 66
- Society & Public Health - 47
- Tourism & Recreation - 3
- Water Supply & Quality - 33

Impacts of recent drought periods in Missouri that affected Marion County are provided below. Unless otherwise indicated, these impacts are from the Drought Impact Reporter:

- Growing belief in Global Warming: October 31, 2015 - Some Americans, witnessing ongoing drought in parts of the U.S., have come to believe that global warming is real. Seven out of 10 people say that solid evidence for global warming exists. This is an uptick of 10 percent since fall 2014 and was nearing the record 72 percent in 2008. More than 60 percent of those acknowledging global warming say that severe drought had a “very large effect” on their view of the matter.
- Grass Growth Hampered, Hay Feeding Underway in Missouri: October 22, 2015 - Dry weather has hampered grass growth in Missouri, forcing farmers to begin feeding hay earlier than usual, which will add to farmers' winter feed bills. Fall grass often supports beef cattle into December. Spring grass production may also be affected by the fall drought.
- Water Restrictions Due to Drought Conditions: August 3, 2015 – Limited water supply due to recent drought conditions is causing governments to restrict the amount of water used by residents and businesses. Agricultural needs are a top priority with residential needs coming in second during drought conditions and water restrictions.
- US Cattle Herd Numbers: February 6, 2015 - Drought reduced the national cattle herd in recent years, but the number of cattle in the country climbed over the last year from 87.7 million to 89.8 million on Jan. 1, 2015, for an increase of one percent. This is the first uptick in cattle numbers since 2007 and shows that herds are being rebuilt faster than expected, say some meat industry publications. Beef prices continued to set new highs.

Information on droughts is very limited since the 1950's according to Missouri State Plan 2013. The table below provides detailed drought information from MO DNR since 1999 taken out of the Missouri State Plan 2013.



**Table 3.18 Missouri Drought Past Occurrence**

DATE	DESCRIPTION
July 1999 to November 1999	In September 1999, a Phase I Drought Advisory was declared for the state of Missouri. Governor Carnahan declared an agricultural emergency for the entire state. Agricultural reporting showed a 50 percent crop loss from the drought in 50 counties, with severe damage to pastures for livestock, corn crops, and Missouri's top cash crop—soybeans. On October 13, 1999, Dan Glickman, USDA secretary declared all Missouri counties agricultural disaster areas, making low-interest loans available to farmers in Missouri and contiguous states. The drought intensity increased through autumn and peaked at the end of November 1999. In fact, the five-month span between July and November became the second driest July-November period in Missouri since 1895, averaging only 9.38 inches of rain.
March 2000 to May 2000	A wetter-than-normal winter diminished dry conditions in central and southern Missouri, but longterm moisture deficits continued to exist. At the same time, the remainder of the State (roughly north of the Missouri River) continued under drought conditions. Overall dry conditions returned through much of the State in March 2000, and costly wildfires and brush fires (70) erupted in many counties. By May, the entire state was under a Phase II Drought Alert level, and on May 23, Governor Carnahan announced activation of the Missouri Drought Assessment Committee (DAC), made up of state and federal agencies and chaired by Jeff Staake the DNR deputy director.
May 2000 to July 2000	At a May 25, 2000, meeting, the DAC selected a subcommittee (guided by the Missouri Drought Plan) to determine the drought status of each county. In June, based on observations across the State and projections of future rainfall, the committee upgraded the drought status for 27 northern Missouri counties to Phase III Conservation. This was based on concerns for water supplies and agricultural impacts. The City of Milan in Sullivan County was among the most severely affected in terms of water supplies. In June, a total of 80 Missouri counties remained under the Phase II Alert level, while 7 counties in southeast Missouri (Butler, Dunklin, Mississippi, New Madrid, Pemiscot, Scott, and Stoddard) remained under Phase I Advisory conditions. By mid-July 2000, some areas of northern Missouri benefited from additional rainfall, while drier conditions prevailed in other areas. At its July 12 meeting, the DAC revised its assessment, placing 30 counties under Phase III Conservation conditions, including 10 counties in the south-central area. The remaining 84 counties in the State were under Phase II Drought Alert conditions. This included seven counties in northern Missouri, which were downgraded from Phase III Conservation, and seven counties in Southeast Missouri, which were previously assessed as Phase I Advisory. To ease the agricultural impact of the drought during the summer months, Governor Carnahan gained release of over one million acres from the Conservation Reserve Program (CRP) to provide farmers and ranchers in 21 counties additional sources to cut hay for livestock feed. Also, livestock producers in 16 counties were released from CRP contracts to allow cattle grazing on certain idle lands.
2002 to June 2004	The drought of 2002 caused tremendous financial hardships to many Missouri crop and livestock producers. The financial impact of the drought on producers in turn impacted the local communities and the State in terms of reduced economic activity. This drought cost an estimated \$46 million in 2002 and \$575 million for 2003 in terms of Missouri's agricultural and economic productivity. Drought conditions encompassed most of the northwestern quarter of Missouri. Severe drought conditions affected the northwest, west-central, and some portions of outhwest Missouri, causing water conservation measures to be taken and restrictions to be imposed. For some areas, this was the second driest year since 1914. The only drier year was in 1988. 2002 had the driest November– December period on record for northwestern and north-central Missouri. The drought continued through 2003 and 2004 with conditions improving in 2004. As of March 3, 2004, drought conditions still encompassed most of the northwestern quarter of Missouri with 18 counties designated as being in Phase III Conservation. The drought conditions improved due to an increase in precipitation between March and June 2004. In June 2004, Missouri was considered drought-free for the first time in three years.
July 2005 to September 2005	The drought of 2005, as in the previous drought of 2003-2004, caused tremendous hardships to many Missouri crop and livestock producers. According to the University of Missouri's Food and Agriculture Institute, the estimated losses to the corn and hay crops alone will likely top \$370 million. For some Missouri farmers, this will be a drier year than 1988. By late July, the drought

	<p>conditions encompassed all but nine counties in the northwestern corner of the State. Severe drought conditions affected counties in the southwest through the northeast part of the State. Effective August 23, 2005, due to the secretarial disaster designation, 114 Missouri counties and St. Louis City were designated as natural disasters for physical and/or production-loss loan assistance from Farm Service Agency (FSA). The drought conditions began to improve by late August and into September.</p>
September 2006 to December 2006	<p>The drought of 2006 has had a tremendous agricultural impact on Missouri farmers. As of September 2006, FSA reported that 26 counties had requested Emergency Conservation Program (ECP) funds with two additional counties pending. The livestock industry is feeling severe effects from the current drought. Hay supplies are short, and water supplies for livestock continue to decline. USDA reported that the new \$50 million program for livestock producers, called the Livestock Assistance Grant Program, will provide this money in Section 32 to states in block grant form. The drought has also had an impact on local water supplies with several communities issuing mandatory conservation measures. On September 19, 2006, only 10 counties in the southeastern portion of the State were free of drought. By November 28, 2006, 5 more counties were drought-free and 11 more had entered Phase III for a total of 49 counties in the Conservation Phase. In October 2006, the USDA designated 85 Missouri counties as a primary natural disaster area (and extended assistance eligibility to 20 contiguous counties) due to losses caused by the drought beginning January 1, 2006. Only the southeast corner and the extreme northwest corner were not eligible for assistance. According to Pat Guinan, University of Missouri climatologist, a snowstorm in late November/early December put a dent in the drought, but more rain and snow are needed for conditions to return to normal.</p>
February 2007 to October 2007	<p>No serious drought conditions have been reported since 2006. The Interim Drought Status map (February 13, 2007) indicates that there were 76 counties in Phase I—Advisory Phase, and 38 counties with no drought. The U.S. Drought Monitor map (July 31, 2007) indicates that several counties north of I-70 and all counties along the Mississippi River to the south had abnormally dry conditions. The Palmer Drought Severity Index map for October 16, 2007, forecasts moderate to extreme drought for most of the counties in Missouri. On October 23, 2007 (see Figure 3.22) shows that there were 61 counties with no drought, 33 counties in Phase I—Advisory Phase, and 20 counties Phase II—Drought Alert.</p>
June 2010 to March 2011	<p>Starting in July 2010, precipitation levels dropped as temperatures remained high, stressing crops in southeast Missouri. Rainfall in late July and August and Tropical Storm Hermine in September gave little relief as water shortage continued. Continued lack of rainfall led to severe (D2) drought conditions in September and extreme (D3) conditions in October the Bootheel region of Missouri. The drought expanded north and west during October and wildfire risk increased due to the dry conditions. Several wildfires occurred in November in Wayne and Carter counties. Precipitation in February provided some relief from the drought and reduced conditions back to severe, then additional rainfall in March further improved the drought status in Missouri.</p>
May 2012 to January 2013 and beyond	<p>May of 2012 brought below average rainfall and resulted in crop damage, low soil moisture levels, and reduced stream flows. By the end of the month, the southern and Bootheel regions of Missouri reached a severe (D2) level drought. In June the drought worsened, meriting an upgrade to an extreme (D3) drought. Fire warnings were high, soybean, corn, and sorghum crops became stressed, and soils moisture levels continued to drop. The drought expanded further into the Ozarks, East Central, Northeast, and Southeast Missouri by the end of June. During July, the drought level was heightened to exceptional (D4) conditions. Crops continued to decline and more livestock had to switch to hay bales for feed. Fourth of July fireworks were canceled due to the dangerously dry conditions. The drought continued for the remainder of 2012 and into 2013. The majority of the state has remained at a severe (D2) drought condition as of January 2013. All counties in Missouri have been declared disaster areas due to the drought.</p>

### ***Probability of Future Occurrence***

In the 20-year period there was 74 months with drought recorded. The annual average percentage probability of drought of 31% was calculated by multiplying 20 (years) times 12 (months) equals 240. The number of months in drought of 74 was divided by the 240 to obtain the annual average percentage probability of drought in the planning area. Although drought is not predictable, long-range outlooks and predicted impacts of climate change could indicate an increased chance of drought.



## **Vulnerability**

### **Vulnerability Overview**

The best and most recent data available is from the Missouri State Plan 2013. Data is not available to quantify vulnerability or estimate losses as a result of drought on State owned facilities. A research investigation was conducted to determine if there was additional non-quantifiable data that could add information or provide a better understanding of the vulnerability of facilities. This information is provided for review purposes only and has not been incorporated into the mitigation analysis however any information of significance has been included below.

Drought has had a significant impact on the planning area and the State has taken an active role in addressing the issue. The Governor, Jay Nixon, took an active role in 2012 in addressing drought conditions and supporting programs that improved conditions for crop and livestock production. The State of Missouri Drought Plan from 2002 provides information on the State's drought response plan. Designed to work in conjunction with the State Consolidated Plan and the State Emergency Operations Plan, the Drought Plan looks at the strategic and tactical measures designed to better prepare Missouri for drought.

The State Department of Natural Resources has a website devoted to addressing drought issue and water management which provides current information on conditions in the State. While not quantifiably vulnerable to drought alone, structures of all kinds are vulnerable to the shrink-swell cycle that occurs as soils swell during wet periods and shrink during dry periods. Of particular concern are MoDOT roads and bridges. Concrete structures like these are not able to expand and contract with the movement of soil and can be damaged or broken as a result. Most of the impacts associated with drought are to crop land, not facilities however there are conservation areas owned and operated by the Missouri Department of Conservation that may be impacted by drought. Many of these are in recreational areas, areas such as are streams, lakes, reservoirs, and ponds that can shrink in size or completely dry up causing the death of fish and other wildlife as well as a potential loss of recreation-based revenue and negatively impact municipal water supply.

### **Potential Losses to Existing Development**

Areas associated with agricultural use are vulnerable to drought conditions which could result in a decrease in crop production or a decrease in available grazing area for livestock. According to the eleven year period for which data is available from USDA's Risk Management Agency.

To determine the anticipated potential losses the historical losses was annualize to determine potential future losses for the planning area to be \$1,524,578 in any given year.

### ***Impact of Future Development***

Future development will remain vulnerable to drought. Typically, some urban and rural areas are more susceptible than others. For example, urban areas are subject to water shortages during periods of drought. Excessive demands of the populated area place a limit on water resources. As population increases this will cause an increased demand for treated water, adding additional strain

on water supply systems. In rural areas, crops and livestock may suffer from extended periods of heat and drought. As the size of farms increase more crops will be exposed to drought-related agricultural losses. Dry conditions can lead to the ignition of wildfires that could threaten residential, commercial and recreational areas. The school districts have no expansion plans 2015.

### Impact of Climate Change

A new analysis, performed for the Natural Resources Defense Council, examined the effects of climate change on water supply and demand in the contiguous United States. The study found that more than 1,100 counties will face higher risks of water shortages by mid-century as a result of climate change. Two of the principal reasons for the projected water constraints are shifts in precipitation and potential evapotranspiration (PET). Climate models project decreases in precipitation in many regions of the U.S., including areas that may currently be described as experiencing water shortages of some degree.

[https://www.nrdc.org/sites/default/files/Missouri\\_With\\_Climate\\_Change.pdf](https://www.nrdc.org/sites/default/files/Missouri_With_Climate_Change.pdf)

### Hazard Summary by Jurisdiction

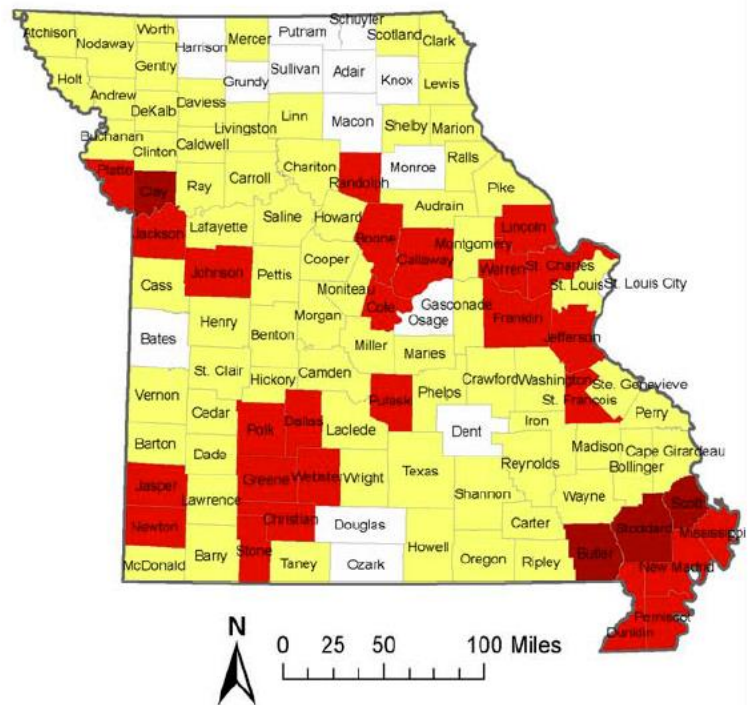
The entire planning area will be affected by drought of some degree. The unincorporated agricultural areas of Marion County are the most vulnerable to drought while the drought condition will also affect the cities except the magnitude would be different with only lawns and local gardens will be impacted. In addition damage to crops, produce, livestock, soil and building foundations could be weakened due to shrinking and expanding soils.

### Problem Statement

Marion County residents are not informed on water conservation, not all citizens comply with warnings, water use would be greatly affected, businesses and residents have continual problems with water shortages.

Education need to occur on water conservation and insure all citizens comply with water shortage warnings and establish plans for businesses and residents on how to survive a drought.

## MISSOURI



### Water Supply Sustainability Index (2050)

Number of Counties for each Category in Parentheses



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### 3.4.3 Earthquakes

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#### Hazard Profile

#### Hazard Description

An earthquake is a sudden motion or trembling that is caused by a release of energy accumulated within or along the edge of the earth's tectonic plates. Earthquakes occur primarily along fault zones and tears in the earth's crust. Along these faults and tears in the crust, stresses can build until one side of the fault slips, generating compressive and shear energy that produces the shaking and damage to the built environment. Heaviest damage generally occurs nearest the earthquake epicenter, which is that point on the earth's surface directly above the point of fault movement. The composition of geologic materials between these points is a major factor in transmitting the energy to buildings and other structures on the earth's surface.

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 Midwest is the New Madrid Seismic Zone. The possibility of the occurrence of a catastrophic earthquake in the central and Eastern United States is real as evidenced by history. The impacts of significant earthquakes affect large areas, terminating public services and systems needed to aid the suffering and displaced. As with hurricanes, mass relocation may be necessary, but the residents who are suffering from the earthquake can neither leave the heavily impacted areas nor receive aid or even communication in the aftermath of a significant event.

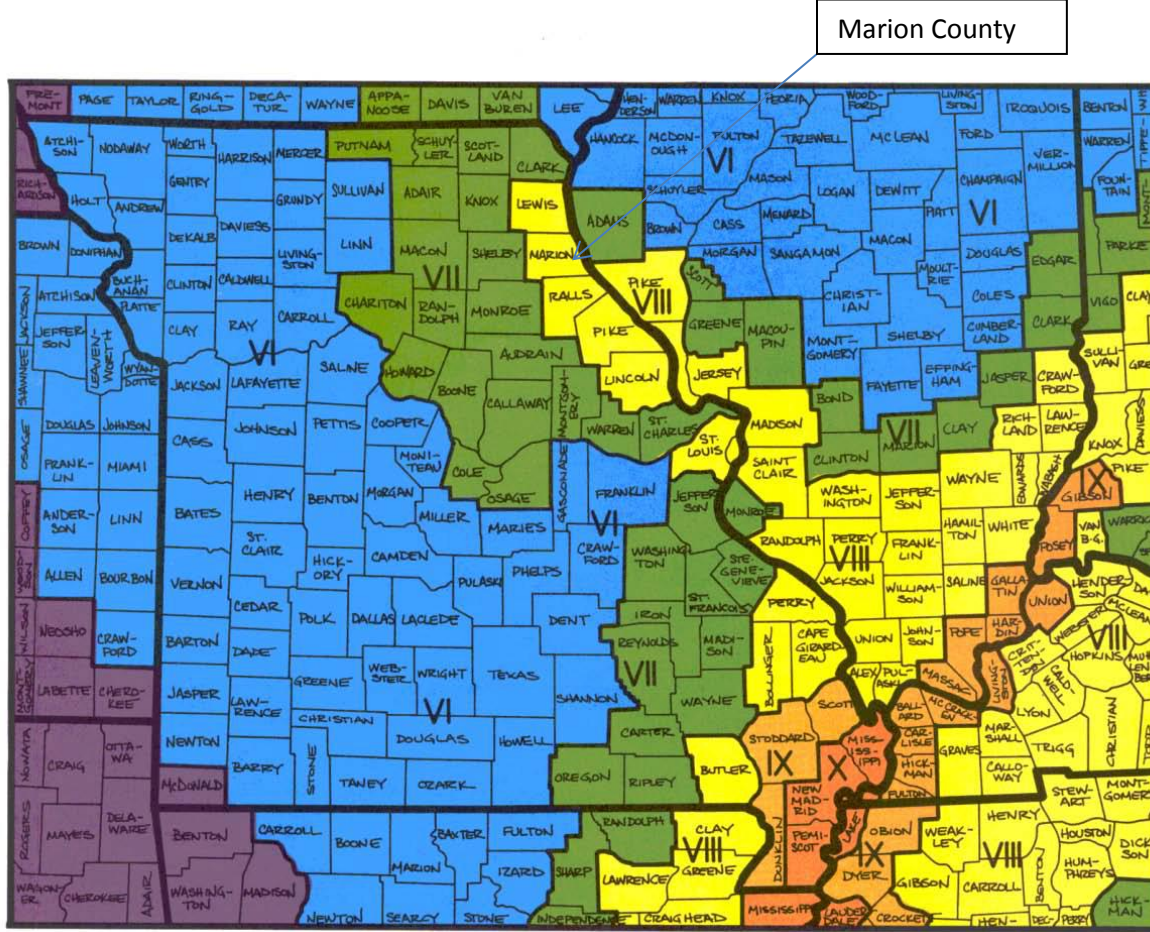
#### Geographic Location

Seismic activity on the New Madrid Seismic Zone of Southeastern Missouri is very significant both historically and at present. On December 16, 1811 and January 23 and February 7 of 1812, three earthquakes struck the central U.S. with magnitudes estimated to be 7.5-8.0. These earthquakes caused violent ground cracking and volcano-like eruptions of sediment (sand blows) over an area of >10,500 km<sup>2</sup>, and uplift of a 50 km by 23 km zone (the Lake County uplift). The shaking was felt over a total area of over 10 million km<sup>2</sup> (the largest felt area of any historical earthquake). Of all the historical earthquakes that have the U.S., an 1811-style event would do the most damage if it recurred today. If an 1811 earthquake occurred in Marion County the earthquake intensity would not vary within the county. Damage would be to buildings of good design and construction, slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures and some chimneys broken.

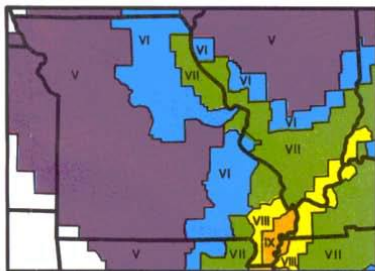
The following SEMA map (Figure 3.6) shows the highest projected Modified Mercalli intensities by county from a potential magnitude 7.6 earthquake whose epicenter could be anywhere along the length of the New Madrid Seismic Zone. The arrow indicates Marion County and the affects that would be felt from an earthquake.



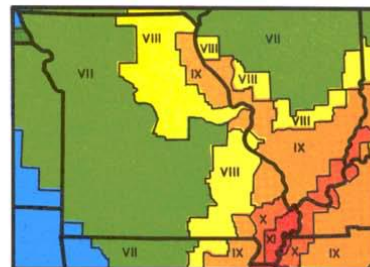
Figure 3.6 Impact Zones for Earthquake Along the New Madrid Fault



This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude - 7.6 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.



This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude - 6.7 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.



This map shows the highest projected Modified Mercalli intensities by county from a potential magnitude - 8.6 earthquake whose epicenter could be anywhere along the length of the New Madrid seismic zone.

Source:

[http://sema.dps.mo.gov/docs/programs/Planning,%20Disaster%20&%20Recovery/State%20of%20Missouri%20Hazard%20Analysis/2012-State-Hazard-Analysis/Annex\\_F\\_Earthquakes.pdf](http://sema.dps.mo.gov/docs/programs/Planning,%20Disaster%20&%20Recovery/State%20of%20Missouri%20Hazard%20Analysis/2012-State-Hazard-Analysis/Annex_F_Earthquakes.pdf)

## PROJECTED EARTHQUAKE INTENSITIES

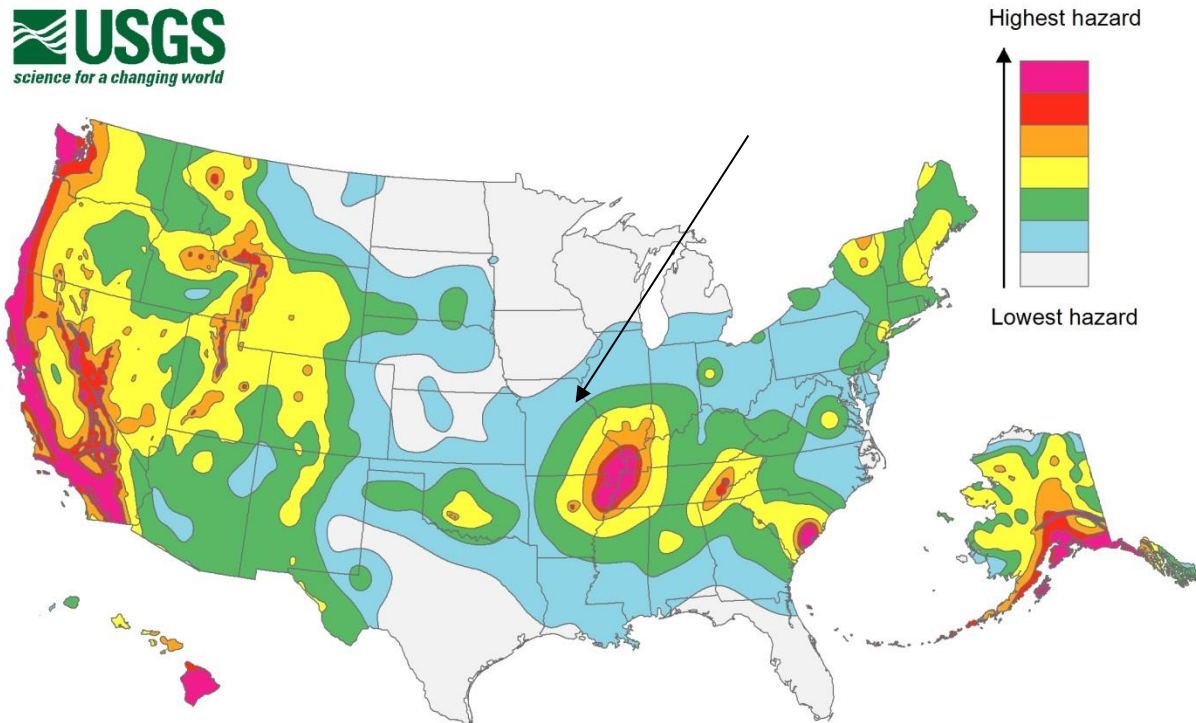
**MODIFIED MERCALLI INTENSITY SCALE**

- I** People do not feel any Earth movement.
- II** A few people might notice movement.
- III** Many people indoors feel movement. Hanging objects swing.
- IV** Most people indoors feel movement. Dishes, windows, and doors rattle. Walls and frames of structures creak. Liquids in open vessels are slightly disturbed. Parked cars rock.
- V** Almost everyone feels movement. Most people are awakened. Doors swing open or closed. Dishes are broken. Pictures on the wall move. Windows crack in some cases. Small objects move or are turned over. Liquids might spill out of open containers.
- VI** Everyone feels movement. Poorly built buildings are damaged slightly. Considerable quantities of dishes and glassware, and some windows are broken. People have trouble walking. Pictures fall off walls. Objects fall from shelves. Plaster in walls might crack. Some furniture is overturned. Small bells in churches, chapels and schools ring.
- VII** People have difficulty standing. Considerable damage in poorly built or badly designed buildings, adobe houses, old walls, spires and others. Damage is slight to moderate in well-built buildings. Numerous windows are broken. Weak chimneys break at roof lines. Cornices from towers and high buildings fall. Loose bricks fall from buildings. Heavy furniture is overturned and damaged. Some sand and gravel stream banks cave in.
- VIII** Drivers have trouble steering. Poorly built structures suffer severe damage. Ordinary substantial buildings partially collapse. Damage slight in structures especially built to withstand earthquakes. Tree branches break. Houses not bolted down might shift on their foundations. Tall structures such as towers and chimneys might twist and fall. Temporary or permanent changes in springs and wells. Sand and mud is ejected in small amounts.
- IX** Most buildings suffer damage. Houses that are not bolted down move off their foundations. Some underground pipes are broken. The ground cracks conspicuously. Reservoirs suffer severe damage.
- X** Well-built wooden structures are severely damaged and some destroyed. Most masonry and frame structures are destroyed, including their foundations. Some bridges are destroyed. Dams are seriously damaged. Large landslides occur. Water is thrown on the banks of canals, rivers, and lakes. Railroad tracks are bent slightly. Cracks are opened in cement pavements and asphalt road surfaces.
- XI** Few if any masonry structures remain standing. Large, well-built bridges are destroyed. Wood frame structures are severely damaged, especially near epicenters. Buried pipelines are rendered completely useless. Railroad tracks are badly bent. Water mixed with sand, and mud is ejected in large amounts.
- XII** Damage is total, and nearly all works of construction are damaged greatly or destroyed. Objects are thrown into the air. The ground moves in waves or ripples. Large amounts of rock may move. Lakes are dammed, waterfalls formed and rivers are deflected.

Intensity is a numerical index describing the effects of an earthquake on the surface of the Earth, on man, and on structures built by man. The intensities shown in these maps are the highest likely under the most adverse geologic conditions. There will actually be a range in intensities within any small area such as a town or county, with the highest intensity generally occurring at only a few sites. Earthquakes of all three magnitudes represented in these maps occurred during the 1811 - 1812 "New Madrid earthquakes." The isoseismal patterns shown here, however, were simulated based on actual patterns of somewhat smaller but damaging earthquakes that occurred in the New Madrid seismic zone in 1843 and 1895.

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P.O. BOX 116  
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**Figure 3.7 United States Seismic Hazard Map**

Source: United States Geological Survey at [http://earthquake.usgs.gov/hazards/products/conterminous/2014/HazardMap2014\\_lg.jpg](http://earthquake.usgs.gov/hazards/products/conterminous/2014/HazardMap2014_lg.jpg)

### **Severity/Magnitude/Extent**

The extent or severity of earthquakes is generally measured in two ways: 1) the Richter Magnitude Scale is a measure of earthquake magnitude; and 2) the Modified Mercalli Intensity Scale is a measure of earthquake severity. The two scales are defined as follows.

#### *Richter Magnitude Scale*

The Richter Magnitude Scale was developed in 1935 as a device to compare the size of earthquakes. The magnitude of an earthquake is measured using a logarithm of the maximum extent of waves recorded by seismographs. Adjustments are made to reflect the variation in the distance between the various seismographs and the epicenter of the earthquakes. On the Richter Scale, magnitude is expressed in whole numbers and decimal fractions. For example, comparing a 5.3 and a 6.3 earthquake shows that the 6.3 quake is ten times bigger in magnitude. Each whole number increase in magnitude represents a tenfold increase in measured amplitude because of the logarithm. Each whole number step in the magnitude scale represents a release of approximately 31 times more energy.

### *Modified Mercalli Intensity Scale*

The intensity of an earthquake is measured by the effect of the earthquake on the earth's surface. The intensity scale is based on the responses to the quake, such as people awakening, movement of furniture, damage to chimneys, etc. The intensity scale currently used in the United States is the Modified Mercalli (MM) Intensity Scale. It was developed in 1931 and is composed of 12 increasing levels of intensity. They range from imperceptible shaking to catastrophic destruction, and each of the twelve levels is denoted by a Roman numeral. The scale does not have a mathematical basis, but is based on observed effects. Its use gives the laymen a more meaningful idea of the severity.

### **Previous Occurrences**

There have been 0 earthquakes recorded in Marion County since 1931.

<http://www.homefacts.com/earthquakes/Missouri/Marion-County.html>

### **Probability of Future Occurrence**

Figure 3.7 demonstrates the probability of an earthquake with a magnitude greater than 5.0 in Marion County in a 50 year time period. The arrow shows the approximate Marion County boundary. As shown in this graphic, the probability of a 5.0 Magnitude or greater earthquake in the next 50 years is .02 percent. The probability converts to an estimated maximum recurrence interval of 5,000 years. The probability of a significant earthquake in any given year is unlikely. Reference the previous map (**Figure 3.7**).

### ***Hazard Summary by Jurisdiction***

Since the earthquake intensity is not likely to vary greatly throughout Marion County, the risk will be the same throughout. However, damages could differ if there are structural variations in the planning area built environment. For example, older structures and those structures which are not in prime condition are likely to experience higher damages.

### ***Impact of Future Development***

Future development is not expected to increase the risk other than contributing to the overall exposure of what could become damaged as a result of an event.



## Vulnerability

### Vulnerability Overview

Missouri State Hazard Mitigation Plan (2013) Analysis: Specific modeling of damage and loss from earthquake scenarios has been conducted for the state using HAZUS 2.1 software; the findings are included in the Missouri State Hazard Mitigation Plan (2013). HAZUS software is used by FEMA to compare relative risk from earthquakes and other natural hazards.

The earthquake vulnerability analysis in the MO State Hazard Mitigation Plan (2013) used demographic data based on the 2010 Census; site specific essential facility data was based on the 2011 HSIP inventory data. Two types of analysis were done:

Annualized Loss Scenario based on eight earthquake return periods (100, 200, 500, 750, 1000, 1500, 2000 and 2500 years)- a “worst case scenario”

### Annualized Loss Scenario

*The MO State Hazard Mitigation Plan (2013) explains the annualized loss scenario as follows:*

HAZUS defines annualized loss as the expected value of loss in any year. The software develops annualized loss estimates by aggregating the losses and their exceedance probabilities from the eight return periods. Annualized loss is the maximum potential annual dollar loss resulting from various return periods averaged on a ‘per year’ basis. It is the summation of all HAZUS- supplied return periods multiplied by the return period probability (as a weighted calculation).

### Potential Losses to Existing Development

The results of the modeling for Marion County are shown below in Figure 3.8

Figure 3.8						
HAZUS-MH Earthquake Loss Estimation						
2% Probability of Exceedance in 50 Years Scenario for Marion County						
Structural Damage	Non-Structural Damage	Contents Damage and Inventory Loss	Loss Ratio %*	Income Loss	Total Economic Loss to Buildings**	Loss Ratio Rank***
\$10,868,000	\$33,599,000	\$11,627,000	1.59	\$16,955,000	\$73,049,000	63
* Loss ratio equals the sum of structural and nonstructural damage divided by the entire building inventory value within the county.						
**Total economic loss includes inventory loss, relocation loss, capital-related loss, wages loss, and rental income loss						
***Out of 115 (114 counties and the City of St. Louis)						
Source: MO State Hazard Mitigation Plan (2013)						

### Impact of Future Development

Overall the planning area has a low vulnerability to earthquake risk. Future development is not expected to increase the risk other than contributing to the overall exposure of what could become damaged as a result of the unlikely event.

### *Hazard Summary by Jurisdiction*

The earthquake intensity is not likely to vary greatly throughout the planning area and all jurisdictions within the planning area will be the same throughout. However, the City of Hannibal could see a

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greater amount of structural damage due to having a higher percentage (34.8%) of residences built prior to 1939 than other jurisdictions in the planning area. The City of Palmyra has a low percentage (16.3) of residences built prior to 1939 putting them at a lower risk.

### **Problem Statement**

Although Marion County is not located in an area that will likely see catastrophic damage from an earthquake, the County will be impacted by the loss of communications, transportation, the disruption of roads, rail and pipelines, water transportation, and the area will see a significant amount of refugees from fleeing from Southern Missouri if a quake hits that area. Education is minimal for earthquakes do to the low likelihood of impact. Hannibal and Palmyra consist of a large number of older tall buildings that are not able to withstand an earthquake event. There is one Emergency Management Director for the County that knows where all the generators and emergency buildings are. Not all citizens utilize social media and texting.

An emergency plan for earthquakes need to be made available to all residents and stated what would happen in the event of an earthquake with details for communications and transportation. Downtown building owners need to know plan in case damage is done to their building. Residents need to be made aware of where the generators and emergency buildings are located. Utilization of social media and texting needs to encouraged.

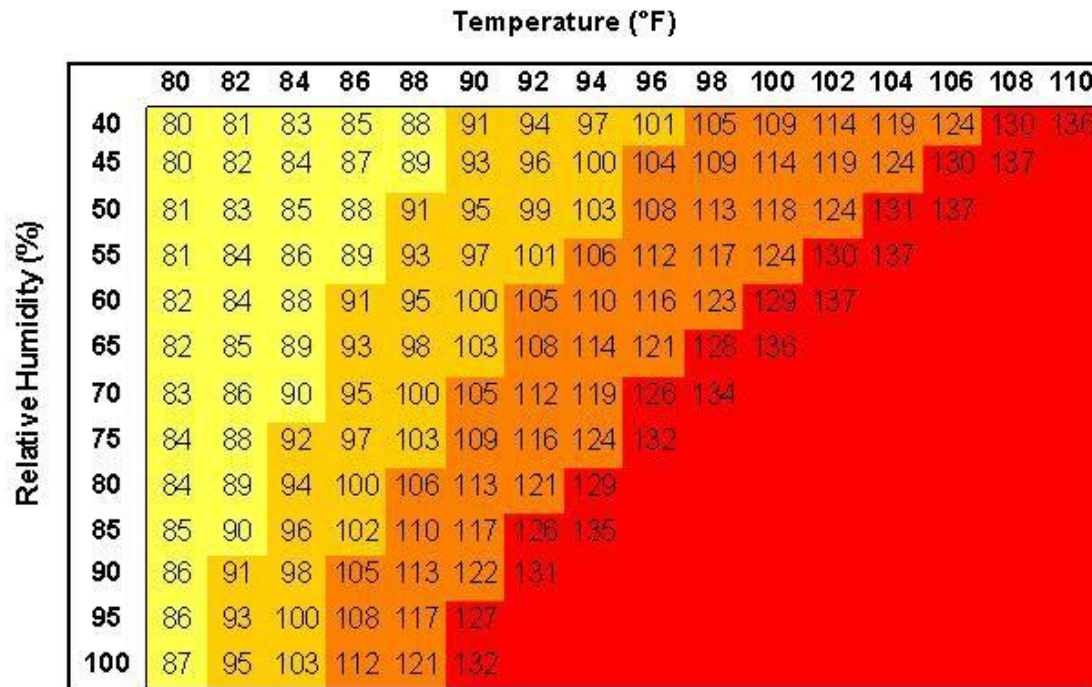
### 3.4.4 Extreme Heat

#### Hazard Profile

#### Hazard Description

Extreme temperature events, both hot and cold, can impact human health and mortality, natural ecosystems, agriculture and other economic sectors. The remainder of this section profiles extreme heat. Extreme cold events are profiled in combination with Winter Storm in **Section 3.4.11**. According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Ambient air temperature is one component of heat conditions, with relative humidity being the other. The relationship of these factors creates what is known as the apparent temperature. The Heat Index chart shown in **0** uses both of these factors to produce a guide for the apparent temperature or relative intensity of heat conditions.

**Figure 3.9 Heat Index (HI) Chart**



**Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity**

- Caution
- Extreme Caution
- Danger
- Extreme Danger

Source: National Weather Service (NWS)

Note: Exposure to direct sun can increase Heat Index values by as much as 15°F. The shaded zone above 105°F corresponds to a HI that may cause increasingly severe heat disorders with continued exposure and/or physical activity.

#### Geographic Location

The entire planning area is subject to extreme heat and all participating jurisdictions are affected.

### Severity/Magnitude/Extent

Extreme heat can cause stress to crops and animals. According to USDA Risk Management Agency, losses to insurable crops during the 10-year time period from 1995 to 2015 were \$889,255.00. Extreme heat can also strain electricity delivery infrastructure overloaded during peak use of air conditioning during extreme heat events. Another type of infrastructure damage from extreme heat is road damage. When asphalt is exposed to prolonged extreme heat, it can cause buckling of asphalt-paved roads, driveways, and parking lots.

From 1988-2011, there were 3,496 fatalities in the U.S. attributed to summer heat. This translates to an annual national average of 146 deaths. During the same period, 0 deaths were recorded in the planning area, according to NCDC data. The National Weather Service stated that among natural hazards, no other natural disaster—not lightning, hurricanes, tornadoes, floods, or earthquakes—causes more deaths.

Those at greatest risk for heat-related illness include infants and children up to five years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications. However, even young and healthy individuals are susceptible if they participate in strenuous physical activities during hot weather. In agricultural areas, the exposure of farm workers, as well as livestock, to extreme temperatures is a major concern.

**Table 3.19 Typical Health Impacts of Extreme Heat**

Heat Index (HI)	Disorder
80-90° F (HI)	Fatigue possible with prolonged exposure and/or physical activity
90-105° F (HI)	Sunstroke, heat cramps, and heat exhaustion possible with prolonged exposure and/or physical activity
105-130° F (HI)	Heatstroke/sunstroke highly likely with continued exposure

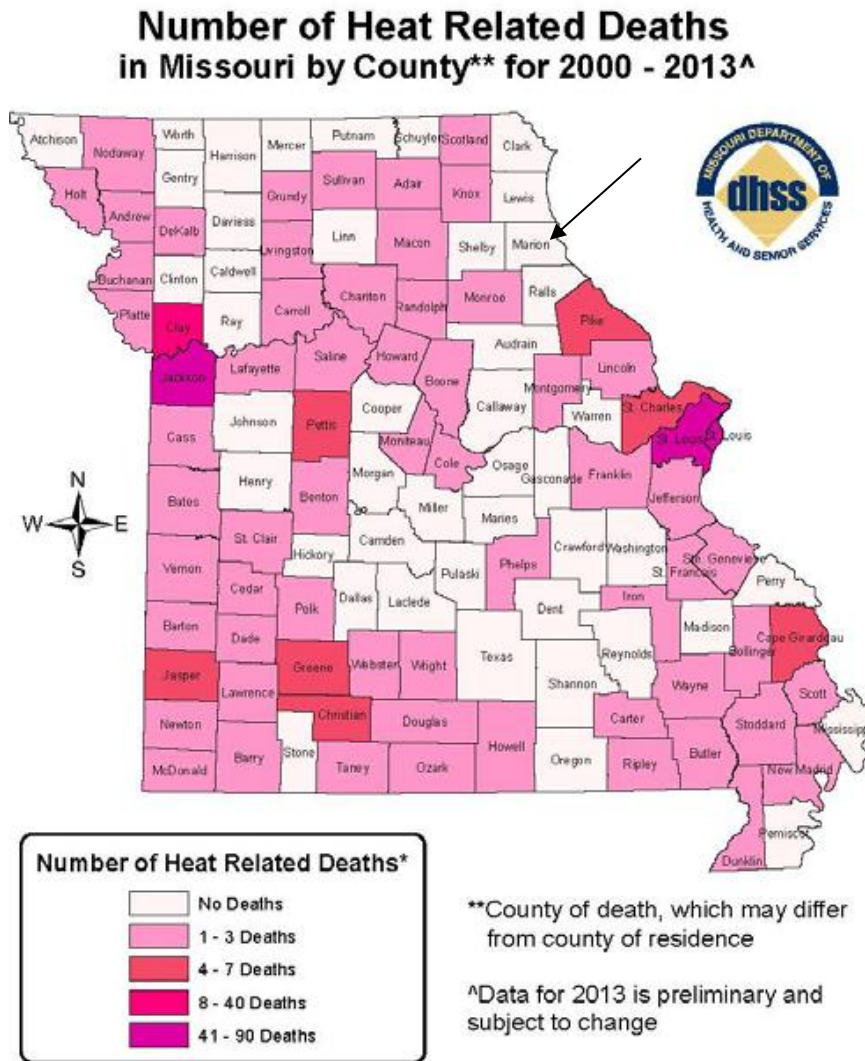
Source: National Weather Service Heat Index Program, [www.weather.gov/os/heat/index.shtml](http://www.weather.gov/os/heat/index.shtml)

The National Weather Service has an alert system in place (advisories or warnings) when the Heat Index is expected to have a significant impact on public safety. The expected severity of the heat determines whether e or warnings are issued. A common guideline for issuing excessive heat alerts is when for two or more consecutive days : (1) when the maximum daytime Heat Index is expected to equal or exceed 105 degrees Fahrenheit (°F); and the night time minimum Heat Index is 80°F or above. A heat advisory is issued when temperatures reach 105 degrees and a warning is issued at 115 degrees.

### Previous Occurrences

According to information obtained from the National Climate Data Center (NCDC) and the Spatial Hazard Events and Losses Database for the United States (SHELDUS) there have been 16 recorded extreme heat events from 1995 to 2015. Additional research was conducted through Google and Yahoo searches and no injury or deaths were reported.

Figure 3.10 Heat Related Deaths in Missouri 2000 - 2013



\*Source: Bureau of Environmental Epidemiology

Date: 6/5/2014

### Probability of Future Occurrence

NOAA dating back to 1995 indicates 14 years without extreme heat events (1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2008, 2013 and 2015). In seven years there were multiple extreme heat events. Based on this historical data, the calculated probability of an extreme heat event in any given year is 33%.

## Vulnerability

### *Vulnerability Overview*

Based on the most recent data available from the 2013 Missouri State Plan the entire planning area is vulnerable to the impacts of extreme heat. However, counties with a higher percentage of elderly may be more at risk due to the heightened vulnerability of this segment of population. According to the data presented in the State Plan Marion County has 15.9 to 18.7% elderly population which is not considered to be a high percentage of elderly residents in Marion County. The figures for the State Plan were based on the US Census Bureau 2010 information.

### *Potential Losses to Existing Development*

During the twenty-one year period from 1995 to 2015 there were \$889,255 in crop insurance claims paid as a result of losses to extreme temperatures. The anticipated loss in any given year can be expected to be the annual average of \$44,462. Illness and loss of life are the most concern with extreme heat however there has not been any injury or deaths related to extreme heat reported in the 20 year period reviewed.

### *Impact of Future Development*

Population growth can result in increases in the age-groups that are most vulnerable to extreme heat. Of the participating jurisdictions that have the highest concentrations of populations vulnerable to extreme heat all saw a decrease in population over the last 10 years. Population growth also increases the strain on electricity infrastructure, as more electricity is needed to accommodate the growing population.

### *Hazard Summary by Jurisdiction*

Those at greatest risk for heat-related illness and deaths include children up to five years of age, people 65 years of age and older, people who are overweight, and people who are ill or on certain medications. To determine jurisdictions within the planning area with populations more vulnerable to extreme heat, demographic data was obtained from the 2010 census on population percentages in each jurisdiction comprised of those under age 5 and over age 65. Data was not available for overweight individuals and those on medications vulnerable to extreme heat. **Table 3.20** below summarizes vulnerable populations in the participating jurisdictions. Note that school and special districts are not included in the table because students and those working for the special districts are not customarily in these age groups.

**Table 3.20 County Population Under Age 5 and Over Age 65, 2010 Census Data**

Jurisdiction	Population Under 5 yrs	Population 65 yrs and over
Marion County	1,985	4,507
Hannibal	1,343	2,669

Source: U.S. Census Bureau

All of the schools in Marion County have air conditioning which does not put school age children at risk during extreme temperatures due to this the schools do not have a policy in affect to close if



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there are extreme temperatures.

**Problem Statement**

Not everyone in Marion County utilizes social media and texting, elderly and young children are most vulnerable to a heat wave. Cooling locations in the County need to be identified and open to everyone for extended hours.

Utilization of social media and texting needs to be promoted. Special attention needs to be paid to insuring the elderly and young children are kept cool and notified of the cooling locations. Education of the cooling locations needs to occur throughout the County.



### 3.4.5 Wild Fires

#### Hazard Profile

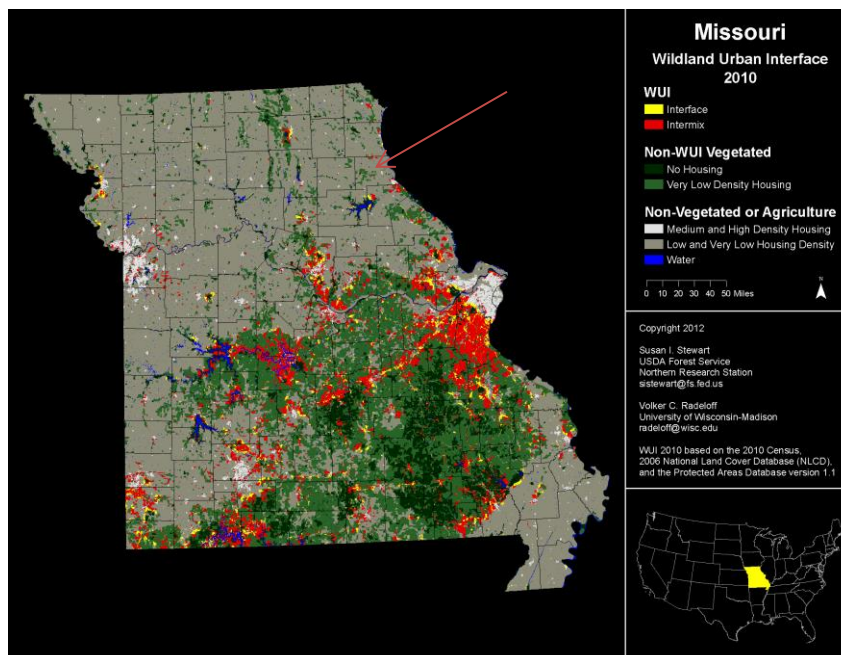
#### Hazard Description

The incident types considered for wild fires incident types include: 1) natural vegetation fire, 2) outside rubbish fire, 3) special outside fire, and 4) cultivated vegetation, crop fire.

The Forestry Division of the Missouri Department of Conservation (MDC) is responsible for protecting privately owned and state-owned forests and grasslands from wildfires. To accomplish this task, eight forestry regions have been established in Missouri for fire suppression. The Forestry Division works closely with volunteer fire departments and federal partners to assist with fire suppression activities. Currently, more than 900 rural fire departments in Missouri have mutual aid agreements with the Forestry Division to obtain assistance in wildfire protection if needed.

Most of Missouri fires occur during the spring season between February and May. The length and severity of both structural and wildland fires depend largely on weather conditions. Spring in Missouri is usually characterized by low humidity and high winds. These conditions result in higher fire danger. In addition, due to the recent lack of moisture throughout many areas of the state, conditions are likely to increase the risk of wildfires. Drought conditions can also hamper firefighting efforts, as decreasing water supplies may not prove adequate for firefighting. It is common for rural residents to burn their garden spots, brush piles, and other areas in the spring. Some landowners also believe it is necessary to burn their forests in the spring to promote grass growth, kill ticks, and reduce brush. Therefore, spring months are the most dangerous for wildfires. The second most critical period of the year is fall. Depending on the weather conditions, a sizeable number of fires may occur between mid-October and late November.

Figure \_\_\_\_ Wildland/Wildfire Urban Interface Map Planning Area Note in Map



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University of Wisconsin Silvis Lab

### **Geographic Location**

As of April 2015, Marion County, Missouri has 2,778.03 acres active in CRP. This translates to 2% percent of the total 135,000 of land acres in the county. Additionally, there is a large number of parks, wildlife areas, and trails in the planning area that are managed by various park boards; this translates to an additional .8 percent land uses consistent with vegetative cover.

At this time, Wildland-Urban Interface area has information not specifically identified for Marion County. If this information becomes available prior to the next update of this plan, it will be be incorporated.

### **Severity/Magnitude/Extent**

Wildfires damage the environment, killing some plants and occasionally animals. Firefighters have been injured or killed, and structures can be damaged or destroyed. The loss of plants can heighten the risk of soil erosion and landslides. Although Missouri wildfires are not the size and intensity of those in the Western United States, they could impact recreation and tourism in and near the fires.

Wildland fires in Missouri have been mostly a result of human activity rather than lightning or some other natural event. Wildfires in Missouri are usually surface fires, burning the dead leaves on the ground or dried grasses. They do sometimes “torch” or “crown” out in certain dense evergreen stands like eastern red cedar and shortleaf pine. However, Missouri does not have the extensive stands of evergreens found in the western US that fuel the large fire storms seen on television news stories.

While very unusual, crown fires can and do occur in Missouri native hardwood forests during prolonged periods of drought combined with extreme heat, low relative humidity, and high wind. Tornadoes, high winds, wet snow and ice storms in recent years have placed a large amount of woody material on the forest floor that causes wildfires to burn hotter and longer. These conditions also make it more difficult for fire fighters suppress fires safely. See <http://www.firewisemissouri.org/wildfire-in-missouri.html>

Often wildfires in Missouri go unnoticed by the general public because the sensational fire behavior that captures the attention of television viewers is rare in the state. Yet, from the standpoint of destroying homes and other property, Missouri wildfires can be quite destructive.

At this time no information is available on the severity of damages from the notable planning area on wildland fires.

### **Previous Occurrences**

According to information obtained from the Missouri Division of Fire Safety (MDFS) Website as well as the Missouri Department of Conversation Wildfire Data Search there were 98 reported wildland or grass fires in Marion County from 2005 to 2016. In total, these 98 fires burned 1,457.55 acres and no injuries were reported. Thirty–seven of the fires had an unknown cause for starting and burning 267.35 acres and 34 were started by a debris. These 34 fires burned 802.25 acres during the eleven year reporting period. <http://mdc4.mdc.mo.gov/applications/FireReporting/Report.aspx> .

At this time no information is available from school districts and special districts about previous fire events and the damages resulting from them.

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### ***Probability of Future Occurrence***

When analyzing the wildland fires, there has been an average of 8.7 fires burning 132.50 acres per year. However, it was reported these fires did not result in major damages. The probability score to be likely in any given year that a wildfire could occur in the planning area.

### **Vulnerability**

#### **Vulnerability Overview**

Wildfires in the planning area are most likely to occur every year with very little resulting damage. The wildfires occur in the unincorporated areas and are limited to undeveloped land. The jurisdictions and school districts are largely surrounded by undeveloped land but have not been affected by wildfires. In years of significant drought or excessive heat the potential for a wildfire in planning area increases.

As outlined in the Missouri 2013 State Plan Marion County was given a high vulnerability rating however this data is based on housing, density, likelihood, building exposure, annualized property loss ratio and death/injury factor. The data for wildfires are insufficient due to only 57% of fire departments in Missouri reporting to the National Fire Incident Reporting System. The majority of the fire departments in the planning area are comprised of volunteers and are limited on the time spent to report information.

#### **Potential Losses to Existing Development**

The potential loss to existing development due to wildfire is difficult to determine due to lack of sufficient historical data. An average number of fires per year has been determined however there are no losses reported associated with the data. Information on historical losses was sought after through various sources including the Missouri Division of Fire Safety and The Missouri Department of Conservation.

#### ***Impact of Future Development***

Future development in the wildland-urban interface would increase vulnerability to the hazard.

#### ***Hazard Summary by Jurisdiction***

The jurisdictions in the planning area are all surrounded by undeveloped agricultural land and face the possibility of a wildfire. The school districts are located within the city and do not have a danger of a wildfire.

### **Problem Statement**

Residents do not comply with burn bans, education is not available for the levels of burn bans, many residents lack education in fire safety and not all residents utilize social media and texting.

Education needs to occur on the dangers associated with not complying with the burn bans, more education for fire safety and encourage utilization of social media and texting.

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### 3.4.6 Flooding (Flash and River)

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#### Profile

#### **Hazard Description**

A flood is partial or complete inundation of normally dry land areas. Riverine flooding is defined as the overflow of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt, or ice. There are several types of riverine floods, including headwater, backwater, interior drainage, and flash flooding. Riverine flooding is defined as the overflow of rivers, streams, drains, and lakes due to excessive rainfall, rapid snowmelt or ice melt. The areas adjacent to rivers and stream banks that carry excess floodwater during rapid runoff are called floodplains. A floodplain is defined as the lowland and relatively flat area adjoining a river or stream. The terms “base flood” and “100- year flood” refer to the area in the floodplain that is subject to a one percent or greater chance of flooding in any given year. Floodplains are part of a larger entity called a basin, which is defined as all the land drained by a river and its branches.

Flooding caused by dam and levee failure is discussed in Section 3.4.1 and Section 3.4.8 respectively. It will not be addressed in this section.

A flash flood occurs when water levels rise at an extremely fast rate as a result of intense rainfall over a brief period, sometimes combined with rapid snowmelt, ice jam release, frozen ground, saturated soil, or impermeable surfaces. Flash flooding can happen in Special Flood Hazard Areas (SFHAs) as delineated by the National Flood Insurance Program (NFIP), and can also happen in areas not associated with floodplains.

Ice jam flooding is a form of flash flooding that occurs when ice breaks up in moving waterways, and then stacks on itself where channels narrow. This creates a natural dam, often causing flooding within minutes of the dam formation.

In some cases, flooding may not be directly attributable to a river, stream, or lake overflowing its banks. Rather, it may simply be the combination of excessive rainfall or snowmelt, saturated ground, and inadequate drainage. With no place to go, the water will find the lowest elevations – areas that are often not in a floodplain. This type of flooding, often referred to as sheet flooding, is becoming increasingly prevalent as development outstrips the ability of the drainage infrastructure to properly carry and disburse the water flow.

Most flash flooding is caused by slow-moving thunderstorms or thunderstorms repeatedly moving over the same area. Flash flooding is a dangerous form of flooding which can reach full peak in only a few minutes. Rapid onset allows little or no time for protective measures. Flash flood waters move at very fast speeds and can move boulders, tear out trees, scour channels, destroy buildings, and obliterate bridges. Flash flooding can result in higher loss of life, both human and animal, than slower developing river and stream flooding.

In certain areas, aging storm sewer systems are not designed to carry the capacity currently needed to handle the increased storm runoff. Typically, the result is water backing into basements, which damages mechanical systems and can create serious public health and safety concerns. This combined with rainfall trends and rainfall extremes all demonstrate the high probability, yet generally unpredictable nature of flash flooding in the planning area.

Although flash floods are somewhat unpredictable, there are factors that can point to the likelihood of

flash floods occurring. Weather surveillance radar is being used to improve monitoring capabilities of intense rainfall. This, along with knowledge of the watershed characteristics, modeling techniques, monitoring, and advanced warning systems has increased the warning time for flash floods.

## Geographic Location

Riverine flooding is most likely to occur in SFHAs. Note that NCDC data includes events for flooding and for flash flooding. In order to obtain information for the following tables, consult event narratives. Those events without location-specific information will be tabulated under “unspecified” locations in the table. Generally, using a 20-year time frame for previous events is adequate. However, where flooding records are scanty, use as many years needed for a solid probability calculation.

## Assets at Risk

This section quantifies the population and buildings exposed to potential hazards, in Marion county. This information was derived from inventory data associated with FEMA’s loss estimation software Hazus 2.1 as found in the Missouri State Hazard Mitigation Plan 2013 . Building inventory counts are based on the 2010 census. Inventory values reflect 2010 valuations, based on RSMeans (a supplier of construction cost information) replacement costs. 2010 Population counts are from the U.S. Census Bureau.

.Marion County: Building Count: Residential 12,893, Commercial 658, Industrial 162, Agriculture 122, Religion 78, Government 39, Education 17, Total 13,969

### Estimated Values for the Key Occupancies (Uses) in Marion County

Residential \$2,129,294 Commercial \$326,165 Industrial \$87,356 Agriculture \$18,234 Religion \$48,949  
Government \$25,924 Education \$153,913 Total \$2,789,835

### Flood Insurance Dollars Paid (Historical) 1978 – 2009

Dollars Paid (Historical)	\$11,481,529
Flood Claims	535
Current Policies	229
Coverage	\$34,485,200

The Hazus analysis provides the number of buildings impacted, estimates of the building repair costs, and the associated loss of building contents and business inventory. Building damage can also cause additional losses to a community as a whole by restricting a building’s ability to function properly. Income loss data accounts for losses such as business interruption and rental income losses as well as the resources associated with damage repair and job and housing losses. These losses are calculated by Hazus using a methodology based on the building damage estimates.

Flood damage is directly related to the depth of flooding. For example, a two -foot-deep flood generally results in about 20 percent damage to the structure (which translates to 20 percent of the structure’s replacement value). Hazus takes into account flood depth when modeling damage (based on FEMA’s depth -damage functions). Hazus reports capture damage by occupancy class (in terms of square footage impacted) by damage percent classes. Occupancy classes in Hazus include agriculture, commercial, education, government, industrial, religion, and residential. Damage percent classes are grouped by 10 percent increments: 1-10



percent, 11-20 percent, etc., up to 50 percent. Buildings that sustain more than 50 percent damage are considered to be substantially damaged.

#### Total Direct Building Loss and Income Loss to Marion County

Structural Damage	\$26,666,903.10
Contents Damage	\$29,603,201.23
Inventory Loss	\$1,723,622.55
Total Direct Loss	\$57,993,742.88
Total Income Loss	\$144,661.18
Total Direct & Income Loss	\$58,138,404.05
Calculated Loss Ratio	3.8

The damaged building counts generated by Hazus are susceptible to rounding errors and are likely the weakest output of the model due to the use of census blocks for analysis. Hazus reports include this disclaimer: “Unlike the earthquake and hurricane models, the flood model performs its analysis at the census block level. This means that the analysis starts with a small number of buildings within each census block and applies a series of distributions necessary for analyzing the potential damage. The application of these distributions and the small number of buildings make the flood model more sensitive to rounding errors that introduces uncertainty into the building count results. Please use these results with suitable caution.” The counts of buildings at risk collected from the local hazard mitigation plans could potentially provide a more realistic estimate of the actual numbers of buildings in the base-flood hazard areas. This information was obtained from the Missouri State Hazard Mitigation Plan 2013.

**Figure 3.11 SFHA North of Highway 36 In the City of Hannibal**

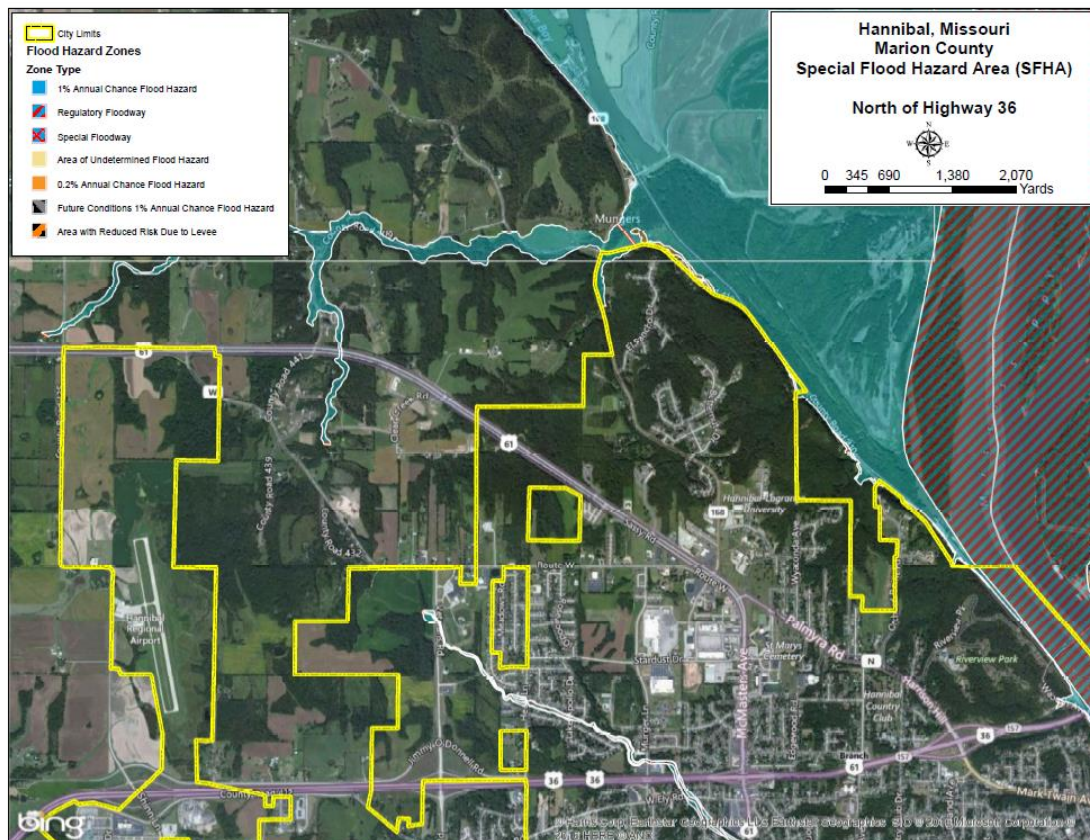




Figure 3.12 SFHA South of Highway 36/East of Highway 61 In the City of Hannibal

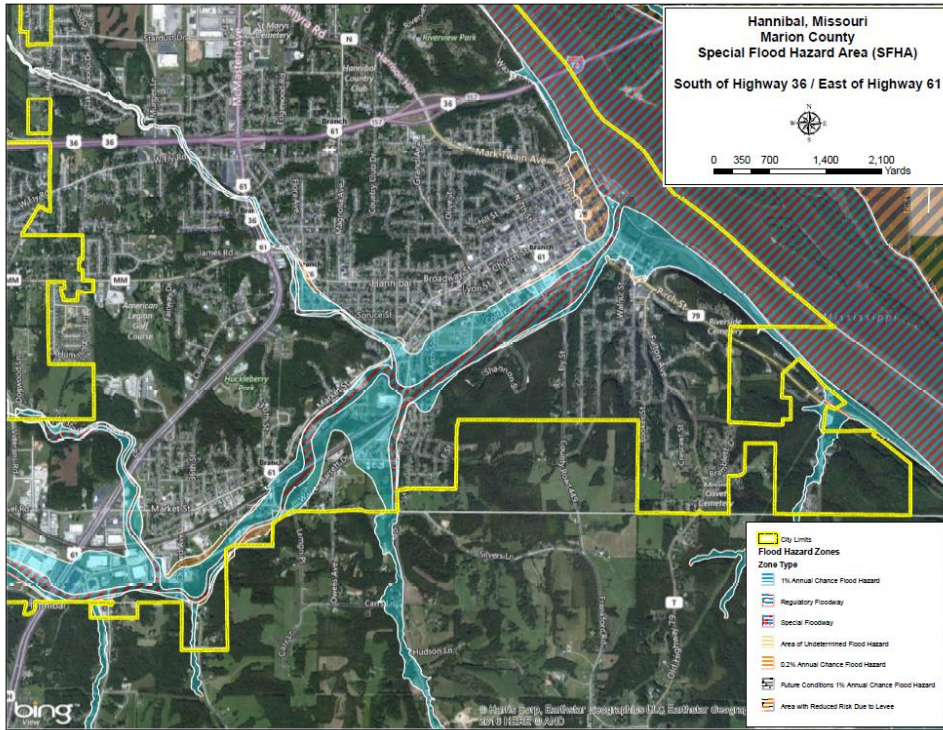


Figure 3.13 SFHA South of Highway 36/West of Highway 61 In the City of Hannibal

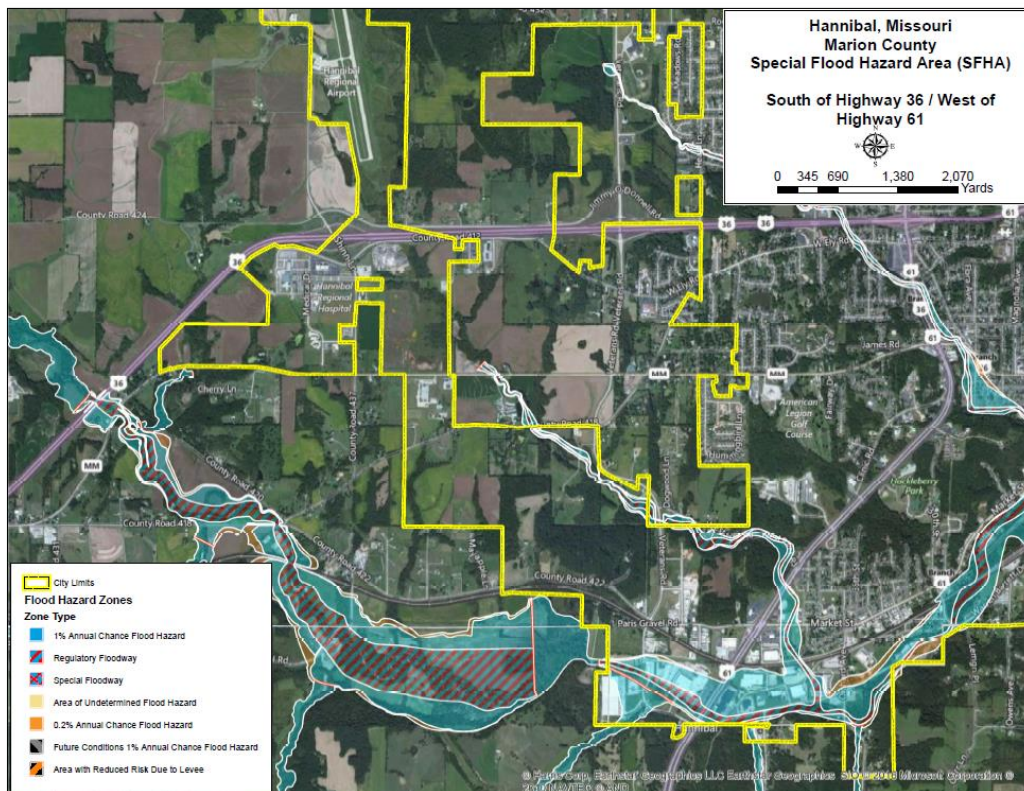
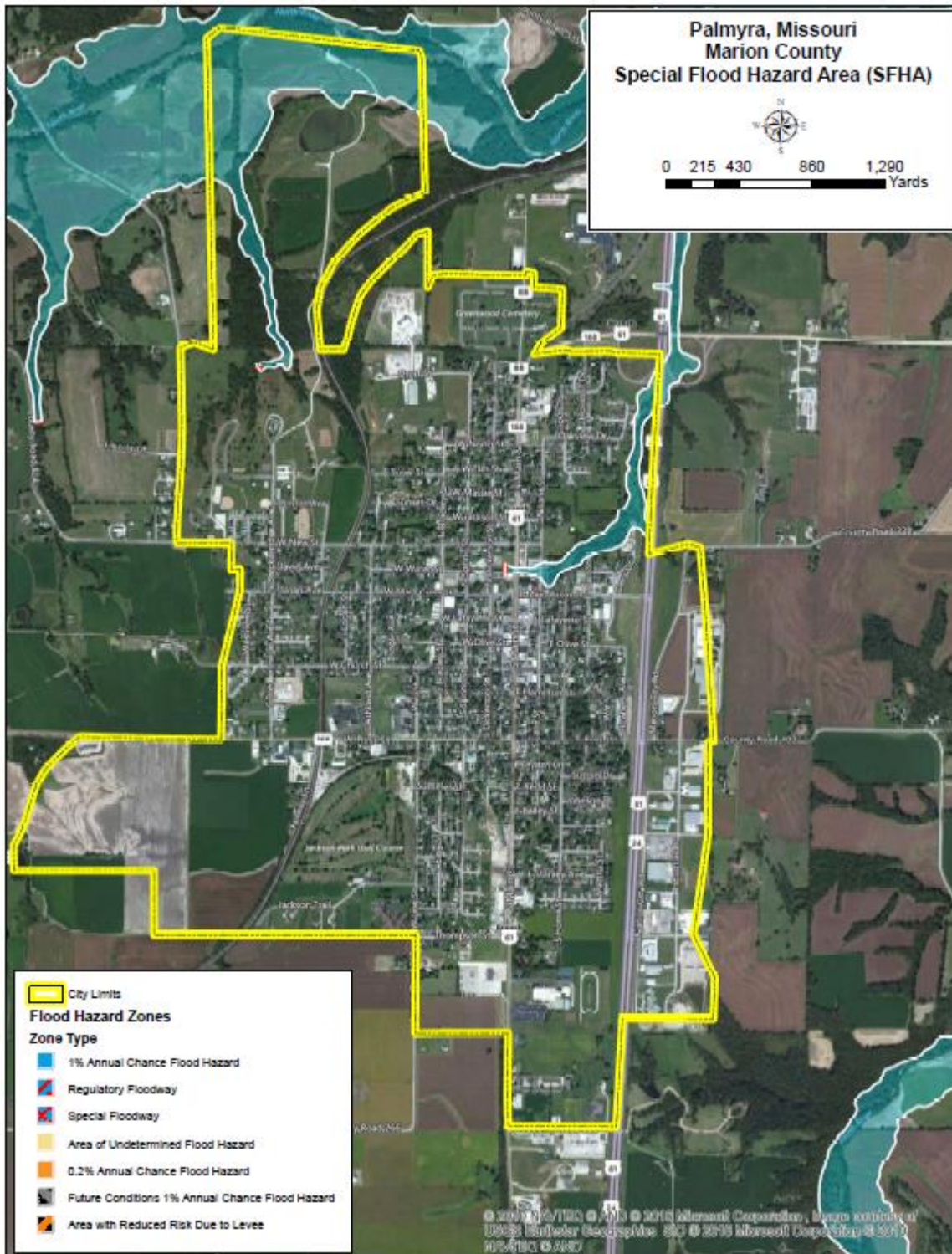




Figure 3.14 SFHA for The City of Palmyra



**Table 3.21 Marion County NCDC Flood Events by Location, 1995-2015**

Location	# of Events
Unincorporated Marion County	11
-Taylor - 1 flood events	
Hannibal	7
-Bear Creek- 3 flood events	
Palmyra	1
-Palmyra- 1 flood events	

Source: National Climatic Data Center

Flash flooding occurs in those locations in the planning area that are low-lying and/or do not have adequate drainage to carry away the amount of water that falls during intense rainfall events. Table 3.22 shows the number of flash flood events by location recorded in NCDC for the 20 year period.

**Table 3.22 Marion County NCDC Flash Flood Events by Location, 1995-2015**

Location	# of Events
Unincorporated Marion County	7
-Unincorporated County (unspecified)- 4 flood events	
-Route J-1 flood events	
-Highway D North of Philadelphia- 1 flood events	
-Highway 61 and 168- 1 flood events	
Hannibal	6
-Bear Creek- 4 flood events	
-Throughout Hannibal- 2 flood events	
Palmyra	1
-Within Palmyra- 1 flood events	
Taylor	1
-Outer Roads - 1 flood events	

Source: National Climatic Data Center

### **Severity/Magnitude/Extent**

Missouri has a long and active history of flooding over the past century, according to the 2010 State Hazard Mitigation Plan. Flooding along Missouri's major rivers generally results in slow-moving disasters. River crest levels are forecast several days in advance, allowing communities downstream sufficient time to take protective measures, such as sandbagging and evacuations. Nevertheless, floods exact a heavy toll in terms of human suffering and losses to public and private property. By contrast, flash flood events in recent years have caused a higher number of deaths and major property damage in many areas of Missouri.

Flooding presents a danger to life and property, often resulting in injuries, and in some cases, fatalities. Floodwaters themselves can interact with hazardous materials. Hazardous materials stored in large containers could break loose or puncture as a result of flood activity. Examples are bulk propane tanks. When this happens, evacuation of citizens is necessary.

Public health concerns may result from flooding, requiring disease and injury surveillance. Community sanitation to evaluate flood-affected food supplies may also be necessary. Private water and sewage sanitation could be impacted, and vector control (for mosquitoes and other entomology concerns) may be necessary.

When roads and bridges are inundated by water, damage can occur as the water scours materials around bridge abutments and gravel roads. Floodwaters can also cause erosion undermining road beds. In some instances, steep slopes that are saturated with water may cause mud or rock slides onto roadways. These damages can cause costly repairs for state, county, and city road and bridge maintenance departments. When sewer back-up occurs, this can result in costly clean-up for home and business owners as well as present a health hazard.

### ***National Flood Insurance Program (NFIP) Participation***

Table 3.23 provides details on NFIP participation for communities in the planning area. Table 3.24 provides details with the number of policies in force, amount of insurance in force, number of closed losses, and total payments for each jurisdiction, where applicable. Identify the time period represented by the data.

**Table 3.23 NFIP Participation in Marion County**

Community ID #	Community Name	NFIP Participant (Y/N)	Current Effective Map Date	Regular-Emergency Program Entry Date
290223	Hannibal	Yes	07/22/10	08/01/77
290222	Marion County	Yes	07/22/10	05/16/77

Source: NFIP Community Status Book, 4/05/2016; BureauNet, <http://www.fema.gov/national-flood-insurance-program/national-flood-insurance-program-community-status-book>; M= No elevation determined – all Zone A, C, and X; NSFHA = No Special Flood Hazard Area; E=Emergency Program

Both the County of Marion and the City of Hannibal actively participate in the NFIP. The County Coordinator is the responsible floodplain manager, while the County EMD is represents the City of Hannibal as the floodplain manager. Both individuals enforce floodplain management ordinances, which generally prohibit development in a SFHA unless proper documentation of elevations is provided. The floodplain managers also monitors all SFHA in each jurisdiction as well as changes in the floodplain. When necessary, both entities work to implement changes in floodplain maps and documentation.

**Table 3.24 NFIP Policy and Claim Statistics as of 02/29/2016**

Community Name	Policies in Force	Insurance in Force	Closed Losses	Total Payments
Hannibal	93	\$15,580,200	248	\$4,005,062.14
Marion County	102	\$18,621,400	217	\$7,895,384.93

Source: NFIP Community Status Book, 4/05/2016; BureauNet, <http://bsa.nfipstat.fema.gov/reports/reports.html>; \*Closed Losses are those flood insurance claims that resulted in payment. Loss statistics are for as of 2/29/2016

Hannibal had the most insurance payments with those payments totaling \$4,005,062.14.

### ***Repetitive Loss/Severe Repetitive Loss Properties***

Repetitive Loss Properties are those properties with at least two flood insurance payments of \$5,000 or more in a 10-year period. According to the Flood Insurance Administration, jurisdictions included in the planning area have a combined total of 45 repetitive loss properties. Since 2011 the City of Hannibal has acquired 42 flood-impacted properties through hazard mitigation grants. In addition, the city has acquired approximately 10 flood-impacted properties, outside the scope of hazard mitigation grant programs.

**Table 3.1. Marion County Repetitive Loss Properties**



Jurisdiction	# of Properties	Type of Property	Building Payments	Content Payments	Total Payments	Average Payment	# of Los
Hannibal	2	Res.	51,411.86	6,534.50	57,946.63	8,278.09	7
Hannibal	5	Comm.	377,559.50	635,172.47	1,012,731.97	59,572.47	17
Hannibal	1	Condo	172,177.07	500,000.00	672,177.07	336,088.54	2
Marion County	10	Res.	376,903.54	61,588.68	438,492.22	25,793.66	17
Marion County	2	Comm.	102,500.00	10,300.00	112,800.00	28,200.00	4
Marion County	1	Condo	17,801.25	8,971.00	26,772.25	13,386.13	2

Source: Flood Insurance Administration as of 2/29/2016

**Severe Repetitive Loss (SRL):** A SRL property is defined it as a single family property (consisting of one-to-four residences) that is covered under flood insurance by the NFIP; and has (1) incurred flood-related damage for which four or more separate claims payments have been paid under flood insurance coverage with the amount of each claim payment exceeding \$5,000 and with cumulative amounts of such claims payments exceeding \$20,000; or (2) for which at least two separate claims payments have been made with the cumulative amount of such claims exceeding the reported value of the property.

### Previous Occurrences



**May 2003- (DR-1463)** Federal Disaster declaration was issued for 74 counties in Missouri.

**April 2006- (DR- 1635)**

**June 2008- (DR-1773)** Federal Disaster declaration was issued in June 2008 due flooding in Northern Missouri. Reports from the state indicated that 2,421 homes were impacted by the flooding with 582 being affected, 535 sustained minor damage, 225 sustained major damage and 1,079 were destroyed.

**August 2010- (DR-1934)**

**July 2013- (DR-4130)** Severe Thunderstorms one week apart; with severe damage across Hannibal and significant property damage. There were over \$600,000 in downed power poles and utility lines.



**August 2015- (DR- 4238)** Federal Disaster declaration was issued for several counties throughout Missouri. Numerous roads were closed in the planning area and debris from flooding caused a bridge to collapse in Marion County. U.S. Highways 24 and 61 were forced to close. Nearly 100 residents were forced to evacuate their mobile homes near Taylor, Missouri when a levee was topped by nearly 10 feet over sandbags causing massive flooding in the Fabius Village Mobile Home Park. The seemingly non-stop rainfall events that caused flooding, loss of park equipment and several landslides- one being a \$332,000 trail repair when a portion of hillside collapsed in a city park.

**Table 3.25 NCDC Marion County Flash Flood Events Summary, 1995 to 2015**

Year	# of Events	# of Deaths	# of Injuries	Property Damages	Crop Damages
1995	1	0	0	0	0
2002	2	0	0	0	0
2004	2	0	0	0	0
2008	3	0	0	0	0

Source: NCDC, data accessed April 7, 2016



**Table 3.26 NCDC Marion County Riverine Flood Events Summary, 1995 to 2015**

Year	# of Events	# of Deaths	# of Injuries	Property Damages	Crop Damages
1996	1	0	0	0	0
2001	4	0	0	0	0
2002	4	0	0	0	0
2007	1	0	0	0	0
2008	3	0	0	7.1M	13.3M
2010	1	0	0	0	0
2013	5	0	0	0	0
Total	19	0	0	7.1M	13.3M

Source: NCDC, data accessed April 7, 2016

## Flood Events

**May 1996-** The Mississippi and Missouri Rivers, and several smaller rivers in the area, flooded during much of May due to heavy spring rains. The heavy rain primarily fell from late April through early May. Rainfall for the month average from 1 to 7 inches above normal with measurable rain falling in the hydrologic service area 16 days during the month. Following are some of the crests reached along the major rivers during month. Most crests ranged from 3 to 7 feet over flood stage. Many of the rises in late April and early May were very rapid, considering the size of the rivers. On the Missouri River at Hermann, the river at one point rose 10 feet in about 24 hours.

For the most part, damage was limited to agricultural lowlands. The buyout programs after the floods of 1993 and 1995 have proved successful. Many now abandoned sites flooded again, as they had done in previous years. Some highlights from areas affected:

Marion County, Hannibal MO: The city floodwall was closed minimizing damage to the downtown area. However areas on the south part of town, primarily along Bear Creek flooded. About 12 businesses suffered damage.

**April 2001-**Rainfall in the upper Mississippi River Basin hastened the snowmelt in Minnesota and Iowa. Although the flood wave attenuated significantly by the time it reached the St. Louis Hydrologic Service Area (HSA), the flooding was still significant. Hannibal, MO reached the 9th highest stage on record, hitting 23.3 feet (flood stage 16) on April 28. Despite the fact that the stages were fairly high, damage was limited. Only 4 businesses sit outside Hannibal's flood levee. The rest were bought out and removed after the flood of record in 1993. Most land flooded was either agricultural or land that was reverted back to natural floodplain after previous floods.

**May 2001-** The bulk of the flooding occurred in agricultural lowlands. In Marion County at Hannibal, the crest was 5 feet below the top of the flood wall. A couple of businesses along Bear Creek south of the flood wall did suffer flood damage. In Pike County, the story was similar. Agricultural lowlands flooded, the riverfront park in Louisiana was flooded, a couple of businesses in Clarksville and Louisiana were flooded, and Highway 79 had to be closed in several places from Louisiana to Clarksville, and Clarksville to Annada. In Lincoln County, an agricultural levee in the Old Monroe area failed on May 18, flooding approximately 1000 acres of farmland. From St. Charles County south to St. Louis damage was minimal with only agricultural lowlands flooded.

**August 2007-** Heavy rain upstream caused minor flooding on the Mississippi River. At Hannibal, the river peaked about 2.5 feet over flood stage and was still in flood when the month ended.

**June 2008-** The Mississippi River at Hannibal, MO crested at 29.54 feet on 6/18/2008. This is the second highest crest ever recorded. The City of Hannibal escaped relatively unscathed as the flood wall and most levees north and south of town held due to work by the National Guard and volunteers. Plastic and sandbags were used to raise and cover about 60% of the levees in the County. The Mark Bottoms levee was over topped resulting in 19 homes being flooded. Highway 79 in the south part of Hannibal was closed. No other towns in the county were affected as the remainder of the land along the river is used for agriculture or conservation purposes. County Extension Service personnel estimated agricultural losses at \$13.3 million. Emergency management personnel reported \$7.1 million in infrastructure damages.

**July 2008-** The Mississippi River crested at Hannibal, MO on July 1 at 25.49 feet. The river fell below flood stage on July 14. For additional information on the flooding consult the June report.

**September 2008-** Four to five inches of rain fell onto already saturated soils causing flooding. Some of the rainfall was from the remnants of Hurricane Ike. Numerous secondary roads were flooded. The heavy rains loosened up soils in the area causing several trees to fall. A large mudslide occurred on Ely Street in Hannibal. Up to ten dump trucks full of mud had to be hauled away from the slide. No structures were affected by the mudslide.

### Flash Flood Events

**August 2004-** Another evening of heavy rain caused flash flooding across parts of Northeast Missouri. Numerous county roads were flooded and damaged by the runoff. Several roads, including Highway 6, and County roads 150, 408, 168, 410 and 320 in the Taylor, Palmyra, and Hannibal areas were impassable most of the night of the 27th. Bear Creek in south Hannibal flooded with water getting into several homes. In Shelby County, Highway W was closed due to water from the North River. Highway AA southeast of Shelbyville was closed by flood water from the North Fork River.

**July 2008-** Three to four inches of rain fell onto already saturated soils in about a 40 minute time frame causing flash flooding. In the southern sections of Hannibal, water was 3 to 4 feet deep in the area of Irwin Street and Bowling Avenue as the nearby creek overflowed its banks. A couple of cars were destroyed in the flood and a couple of mobile homes had some water damage.

**April 2009-** Between 2 and 3 inches of rain fell in a short amount of time causing flash flooding. There were areas of flash flooding around Bear Creek, Munger Lane Bridge was washed out and many county roads were closed due to high water.

**July 2010-** Up to 6 inches of rain fell in a short amount of time causing flash flooding. Numerous roads were flooded including several in Hannibal. Also, Bear Creek in Hannibal overflowed its banks flooding a nearby parking lot with two feet of water and 35 to 40 residents along the creek had to be rescued from their homes by boat due to the flooding.

**September 2010-** Up to four inches of rain fell in a short amount of time causing flash flooding. Numerous roads were flooded including outer roads along U.S. Highway 61 near Taylor.

**May 2013-** Up to three inches of rain fell in a short amount of time causing flash flooding in the Hannibal and Palmyra areas. Several roads were flooded including the intersection of U.S. Highway 61 and Highway 168.

**July 2015-** Up to five inches of rain fell onto already saturated soils causing flash flooding. Numerous roads were flooded including Highway MM at Bear Creek, County Roads 425 and 403. Several homes in Hannibal had up to 17 inches of water in their basements.

**July 2015-** Up to three inches of rain fell in a short amount of time causing flash flooding. Numerous roads were flooded. In Hannibal, water was high enough on some streets to get into vehicles. No injuries or deaths were reported.

### **Probability of Future Occurrence**

With the extensive history of flooding in the planning area, it is highly likely that flooding of various levels will continue to occur frequently. The probability of a flood event occurring in the planning area in any given year is 95%. Flash floods occur often in the planning area and have a 75% probability of occurring in any given year.

### **Vulnerability**

#### **Vulnerability Overview**

Flooding in the planning area has caused significant damage throughout with 19 documented flood events in the last 20 years making flooding a 95% probability flooding will occur in any given year.

#### ***Potential Losses to Existing Development***

An estimate for the potential loss to existing development was not able to be obtained and included in this plan for Marion County.

#### ***Impact of Future Development***

Any future development in floodplains would increase risk in those areas. For those communities that participate in the National Flood Insurance Program, enforcement of the floodplain management regulations will ensure mitigation of future construction in those areas. However, even if structures are mitigated, evacuation may still be necessary due to rising waters. In addition, floods that exceed mitigated levels may still cause damages.

#### ***Hazard Summary by Jurisdiction***

Vulnerability to flood varies by jurisdiction. The floodplain map in the geographic location section shows the greatest risk to be within the City of Hannibal. The previous table 3.19 shows that 19 flood events occurring during the last 20 years of data.

### **Problem Statement**

Flooding or flash flooding has effected every community in Marion County which has impacted homes and business, not everyone utilizes social media or texting, Hannibal sits along the Mississippi river which is prone to flooding and education is deficient in what to do in the event of a flood. Possible solutions is to increase the education to residents, promote the use of social media or texting and work with officials to identify flood prone areas.

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### 3.4.7 Land Subsidence/Sinkholes

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#### Hazard Profile

#### Hazard Description

Sinkholes are common where the rock below the land surface is limestone, carbonate rock, salt beds, or rocks that naturally can be dissolved by ground water circulating through them. As the rock dissolves, spaces and caverns develop underground. The sudden collapse of the land surface above them can be dramatic and range in size from broad, regional lowering of the land surface to localized collapse. However, the primary causes of most subsidence are human activities: underground mining of coal, groundwater or petroleum withdrawal, and drainage of organic soils. In addition, sinkholes can develop as a result of subsurface void spaces created over time due to the erosion of subsurface limestone (karst).

Land subsidence occurs slowly and continuously over time, as a general rule. On occasion, it can occur abruptly, as in the sudden formation of sinkholes. Sinkhole formation can be aggravated by flooding.

In the case of sinkholes, the rock below the surface is rock that has been dissolving by circulating groundwater. As the rock dissolves, spaces and caverns form, and ultimately the land above the spaces collapse. In Missouri, sinkhole problems are usually a result of surface materials above openings into bedrock caves eroding and collapsing into the cave opening. These collapses are called “cover collapses” and geologic information can be applied to predict the general regions where collapse will occur. Sinkholes range in size from several square yards to hundreds of acres and may be quite shallow or hundreds of feet deep.

According to the U.S. Geological Survey (USGS), the most damage from sinkholes tends to occur in Florida, Texas, Alabama, Missouri, Kentucky, Tennessee, and Pennsylvania. Fifty-nine percent of Missouri is underlain by thick, carbonate rock that makes Missouri vulnerable to sinkholes. Sinkholes occur in Missouri on a fairly frequent basis. Most of Missouri’s sinkholes occur naturally in the State’s karst regions (areas with soluble bedrock). They are a common geologic hazard in southern Missouri, but also occur in the central and northeastern parts of the State. Missouri sinkholes have varied from a few feet to hundreds of acres and from less than one to more than 100 feet deep. The largest known sinkhole in Missouri encompasses about 700 acres in western Boone County southeast of where Interstate 70 crosses the Missouri River. Sinkholes can also vary in shape like shallow bowls or saucers whereas other have vertical walls. Some hold water and form natural ponds.

#### Geographic Location

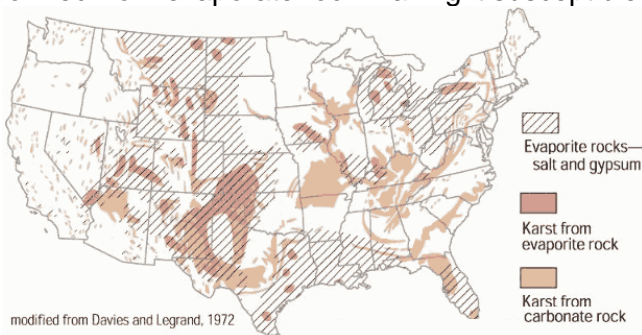
The Missouri Department of Natural Resources documented more than 55 sinkholes in the planning area. They are mainly located in the southeastern part of the planning area near Hannibal.

The majority of the sinkholes are in one area and are in the very rural area of the planning area. The sinkholes are in the eastern or southeastern part of the county and are close to large deposits of karst.

**Figure 3.15 Sinkholes in Marion County**

<http://dnr.mo.gov/geology/images/SinkholesInMissouri031513.jpg>

The map in Figure 3.15 shows areas of the United States where certain rock types that are susceptible to dissolution in water occur. In these areas the formation of underground cavities can form and catastrophic sinkholes can happen. These rock types are evaporites (salt, gypsum, and anhydrite) and carbonates (limestone and dolomite). Evaporite rocks underlie about 35 to 40 percent of the United States, though in many areas they are buried at great depths. Marion County has Karst formed from evaporate rock making it susceptible for sinkholes to occur.



### **Severity/Magnitude/Extent**

Sinkholes vary in size and location, and these variances will determine the impact of the hazard. A sinkhole could result in the loss of a personal vehicle, a building collapse, or damage to infrastructure such as roads, water, or sewer lines. Groundwater contamination is also possible from a sinkhole. Because of the relationship of sinkholes to groundwater, pollutants captured or dumped in sinkholes could affect a community's groundwater system. Sinkhole collapse could be triggered by large earthquakes. Sinkholes located in floodplains can absorb floodwaters but make detailed flood hazard studies difficult to model.

The 2013 State Plan included only seven documented sinkhole “notable events”. The plan stated that sinkholes are common to Missouri and the probability is high that they will occur in the future. To date, Missouri sinkholes have historically not had major impacts on development nor have they caused serious damage. Thus, the severity of future events is likely to be low.

<http://www.foundation-repair-guide.com/expansive-soil.html>

[http://www.ehow.com/list\\_6880295\\_properties-expansive-soils.html](http://www.ehow.com/list_6880295_properties-expansive-soils.html)

### **Previous Occurrences**

According to the Missouri 2010 State Plan sinkholes are a regular occurrence in Missouri, but are rarely the events of any significance. The Missouri State Hazard Mitigation Plan lists seven notable sinkhole events with none of them occurring in the planning area.

Although Marion County has over 55 sinkholes they have not been a problem and the likeliness of a future occurrence would be considered negligible. However, the potential for this type of hazard to occur in Marion County exists. There are portions of the county where sinkholes and underground caverns exist and can increase the likely hood of a sinkhole occurring.

### ***Probability of Future Occurrence***

The likely hood of a sinkhole occurring of any significance is low based on the past history of the sinkholes recorded. Due to data limitations precluding a probability calculation, such as the lack of a centralized database for sinkhole occurrences in the state.

### **Vulnerability**

#### ***Vulnerability Overview***

Sinkholes in the planning area are not a common occurrence due to composition of the land. While some sinkholes may be considered a slow changing nuisance; other more sudden, catastrophic collapses can destroy property, delay construction projects, and contaminate ground water resources.

#### ***Sinkholes***

The data from the Missouri Spatial Data Information Service website, <http://msdis.missouri.edu/>, shows the location of 55 sinkholes for the planning area. These sinkholes can vary from a few feet to hundreds of acres and from less than one to more than 100 feet deep. They can also vary in shape like shallow bowls or saucers whereas other have vertical walls, some hold water and form natural ponds. There are no statistics on the number of voids present in the subsurface that will collapse in the future to form new surface sinkholes, however, areas have been identified that have the greatest potential for future sinkholes and land subsidence.

#### ***Mines***

The Missouri Mine Map Repository maintained by the Missouri Department of Natural Resources did not include any mines in Marion County. The Missouri Department of Natural Resources Division of Geology and Land Survey shows there is production of construction sand and gravel occurring in Marion County. Production of <http://dnr.mo.gov/geology/adm/publications/docs/map-MinRes.pdf>

#### ***Caves***

According to the Journal of Cave and Karst Studies, December 2003 Marion County has 360 documented caves with 81.2% being network caves. The planning area has caves open to the public.



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### ***Potential Losses to Existing Development***

The potential impact of sinkholes on existing structures is difficult to determine due to the lack of data on historic damages caused by sinkholes and even either the mapping of potential sinkholes it is difficult if not impossible to predict where a sinkhole will collapse and how significant the collapse will be.

Because sinkhole collapse is not predictable and previous events have occurred in the rural area there is not significant data to estimate the future losses due to a sinkhole.

### ***Impact of Future Development***

As more development occurs on unmapped rural areas the vulnerability to the hazard will increase; however sinkholes are unpredictable and the development in rural areas is difficult to limit due to the lack of occurrence.

Marion County is documented to have a large number of caves and the future development over existing caves can have an impact on this hazard. The installation of residential services such as septic tanks, lagoons, and structures can cause shifts in the karst deposit located in the planning area and allow the formation of a sinkhole.

### ***Hazard Summary by Jurisdiction***

The risk for the development is uniform throughout the planning and has not affected one jurisdiction specifically.

### **Problem Statement**

Sinkholes can occur at anytime and without warning and vary by size. There can be a disruption of transportation services and not residents in the dangerous areas are not educated on what to do in if a sinkhole occurs.

Education needs to occur in the danger areas of a sinkhole occurring and what to do if a sinkhole does occur.

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### 3.4.8 Levee Failure

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#### Hazard Profile

#### Hazard Description

Levees are earth embankments constructed along rivers and coastlines to protect adjacent lands from flooding. Floodwalls are concrete structures, often components of levee systems, designed for urban areas where there is insufficient room for earthen levees. When levees and floodwalls and their appurtenant structures are stressed beyond their capabilities to withstand floods, levee failure can result in injuries and loss of life, as well as damages to property, the environment, and the economy.

Levees can be small agricultural levees that protect farmland from high-frequency flooding. Levees can also be larger, designed to protect people and property in larger urban areas from less frequent flooding events such as the 100-year and 500-year flood levels. For purposes of this discussion, levee failure will refer to both overtopping and breach as defined in FEMA's Publication "So You Live Behind a Levee" (<http://content.asce.org/ASCELeveeGuide.html>). Following are the FEMA publication descriptions of different kinds of levee failure.

#### **Overtopping: When a Flood Is Too Big**

Overtopping occurs when floodwaters exceed the height of a levee and flow over its crown. As the water passes over the top, it may erode the levee, worsening the flooding and potentially causing an opening, or breach, in the levee.

#### **Breaching: When a Levee Gives Way**

A levee breach occurs when part of a levee gives way, creating an opening through which floodwaters may pass. A breach may occur gradually or suddenly. The most dangerous breaches happen quickly during periods of high water. The resulting torrent can quickly swamp a large area behind the failed levee with little or no warning.

Earthen levees can be damaged in several ways. For instance, strong river currents and waves can erode the surface. Debris and ice carried by floodwaters—and even large objects such as boats or barges—can collide with and gouge the levee. Trees growing on a levee can blow over, leaving a hole where the root wad and soil used to be. Burrowing animals can create holes that enable water to pass through a levee. If severe enough, any of these situations can lead to a zone of weakness that could cause a levee breach. In seismically active areas, earthquakes and ground shaking can cause a loss of soil strength, weakening a levee and possibly resulting in failure. Seismic activity can also cause levees to slide or slump, both of which can lead to failure.

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## Geographic Location

Missouri is a state with many levees. Currently, there is no single comprehensive inventory of levee systems in the state. Levees have been constructed across the state by public entities and private entities with varying levels of protection, inspection oversight, and maintenance. The lack of a comprehensive levee inventory is not unique to Missouri.

There are two concurrent nation-wide levee inventory development efforts, one led by the United States Army Corps of Engineers (USACE) and one led by Federal Emergency Management Agency (FEMA). The National Levee Database (NLD), developed by USACE, captures all USACE related levee projects, regardless of design levels of protection. The Midterm Levee Inventory (MLI), developed by FEMA, captures all levee data (USACE and non-USACE) but primarily focuses on levees that provide 1% annual-chance flood protection on FEMA Flood Insurance Rate Maps (FIRMs).

It is likely that agricultural levees and other non-regulated levees within the planning area exist that are not inventoried or inspected. These levees that are not designed to provide protection from the 1-percent annual chance flood would overtop or fail in the 1-percent annual chance flood scenario. Therefore, any associated losses would be taken into account in the loss estimates provided in the Flood Hazard Section.

For purposes of the levee failure profile and risk assessment, those levees indicated on the Preliminary DFIRM as providing protection from at least the 1-percent annual chance flood will be discussed and further analyzed. It is noted that increased discharges are being taken into account in revision of the flood maps as part of the RiskMap efforts. This may result in changes to the flood protection level that existing levees are certified as providing.

Research revealed three levees in Marion County on the National Levee Database maintained by the U.S. Army Corps of Engineers (USACE) and one on the DFIRM with the intent to provide some level of flood protection to the built environment.

- The Hannibal, MO levee, constructed in 1960 along the Mississippi River provides protection to the downtown district for the City of Hannibal. Operation and maintenance has been turned over to public sponsorship.

- Bear Creek Dry Reservoir levee was constructed by the U.S. Army Corps of Engineers and turned the levee over to public sponsorship in the early 1970's. The levee protection type is agricultural.

- South River Drainage District levee, constructed in 1939 is over 13 miles long and provides agricultural protection. Operation and maintenance has been turned over to public sponsorship.

- City of Fabius, constructed in 1941 is 17.3 miles long and provides protection to 14,300 acres of mainly agricultural land. Although most is cropland 400 acres is commercial and industrial use.

The following maps shows the levees and the areas protected from the 1-percent annual chance flood on the DFIRM or FIRM.

**Figure 3.16 Marion County Levees Shown on DFIRM as Providing Protection from the 1 – Percent Annual Chance Flood**

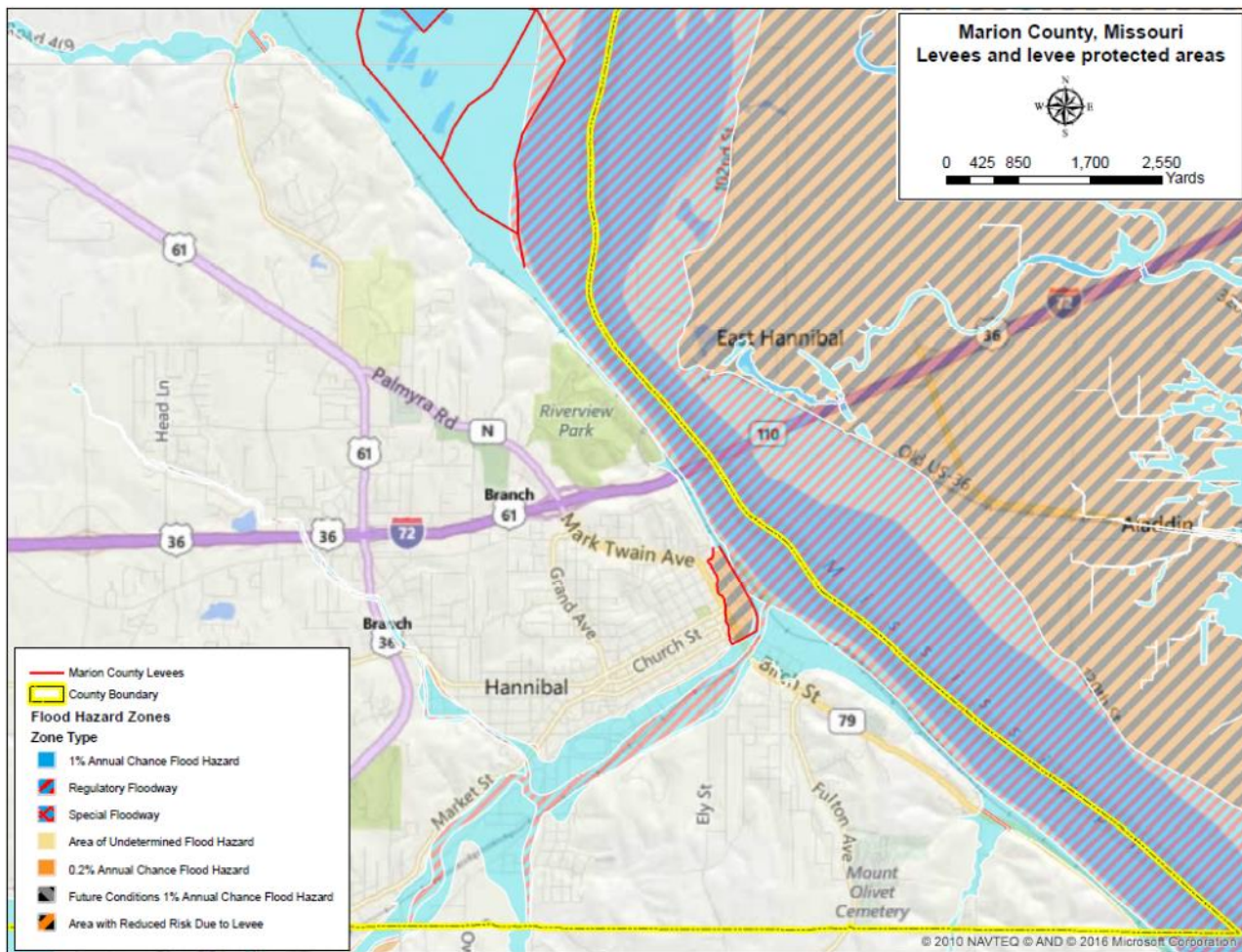
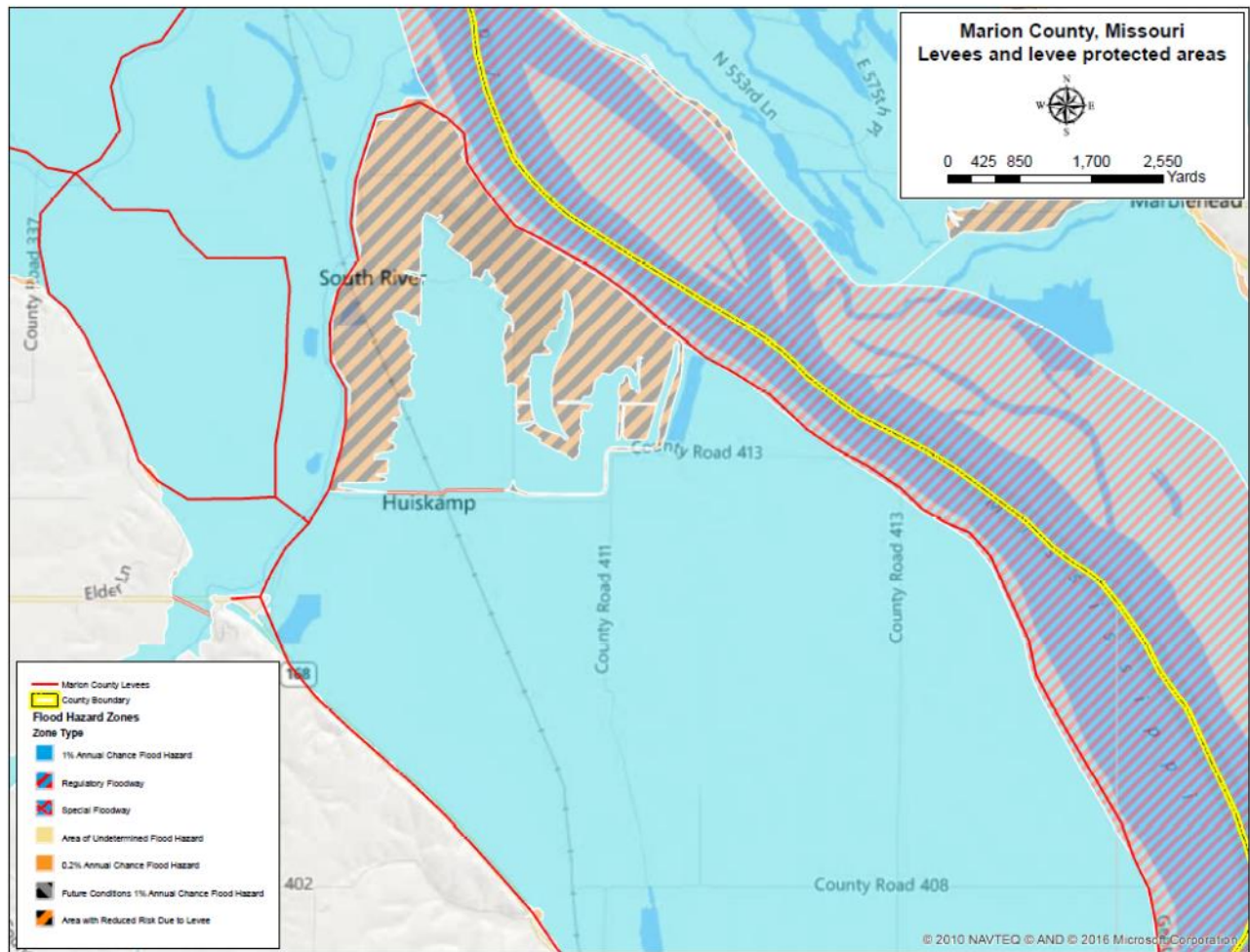
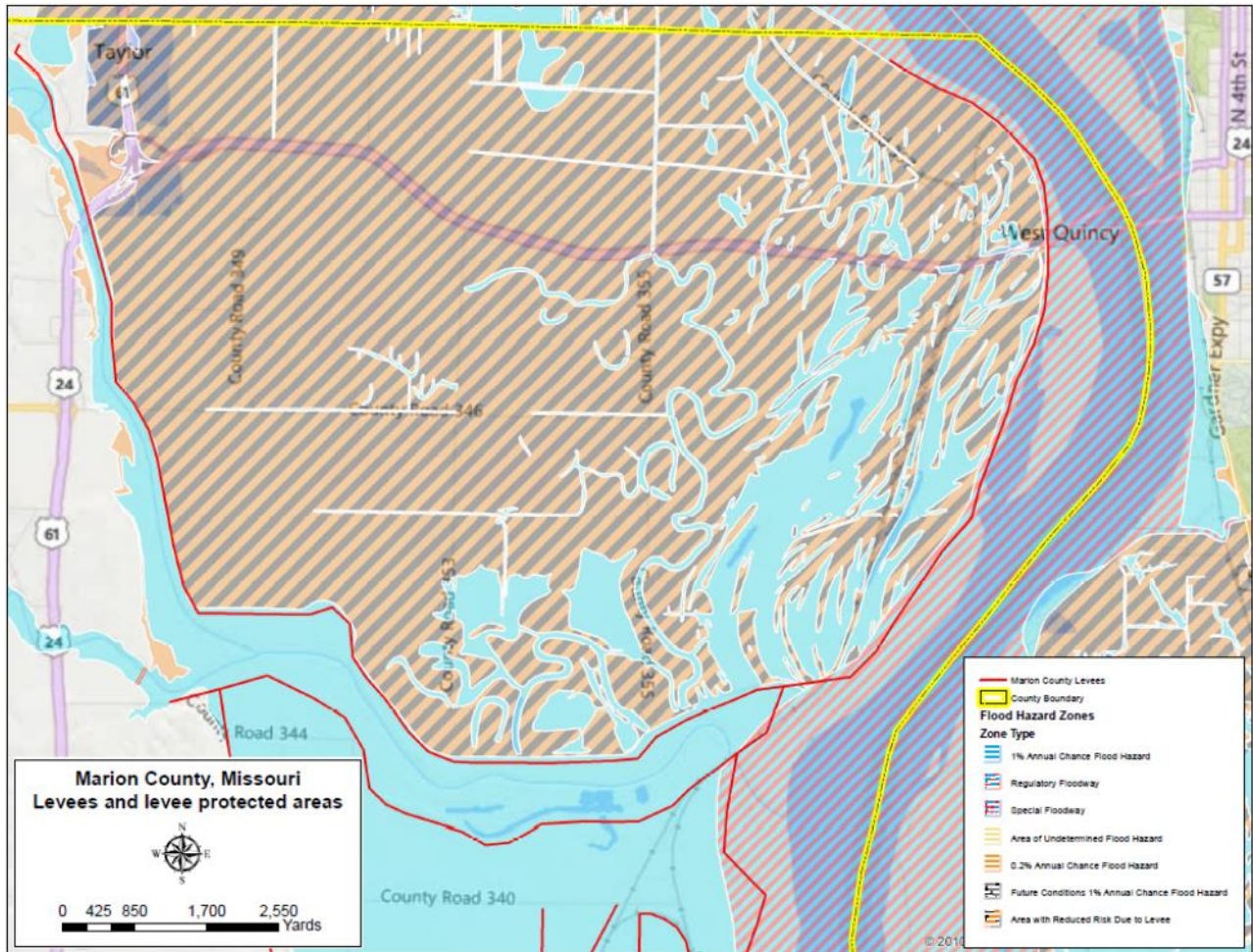




Figure 3.17 Marion County Levees Shown on DFIRM as Providing Protection from the 1 – Percent Annual Chance Flood

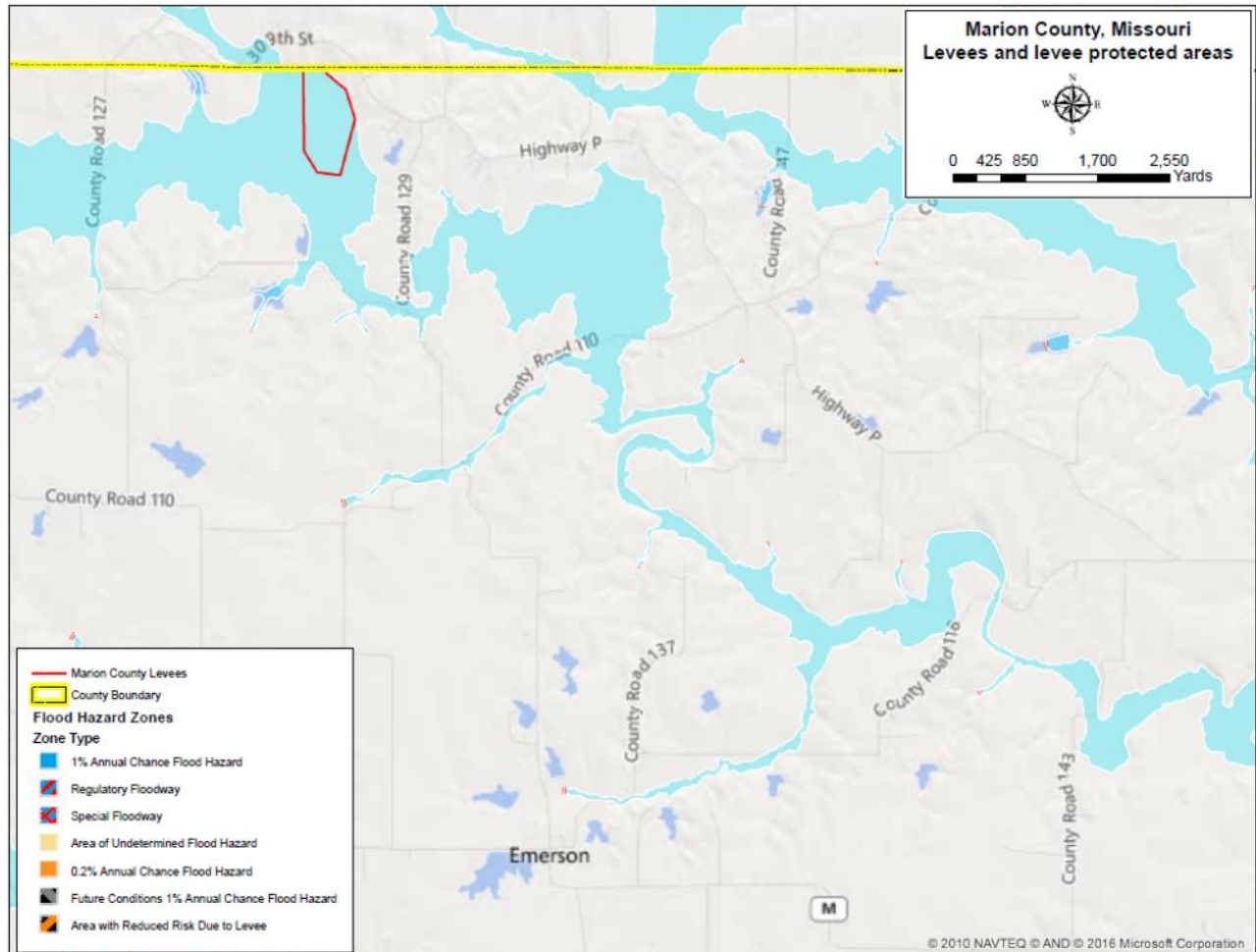


**Figure 3.18 Marion County Levees Shown on DFIRM as Providing Protection from the 1 – Percent Annual Chance Flood**





**Figure 3.19 Marion County Levees Shown on DFIRM as Providing Protection from the 1 – Percent Annual Chance Flood**



Source: FEMA Flood Insurance Rate Map, date

### Severity/Magnitude/Extent

Levee failure is typically an additional or secondary impact of another disaster such as flooding or earthquake. The main difference between levee failure and losses associated with riverine flooding is magnitude. Levee failure often occurs during a flood event, causing destruction in addition to what would have been caused by flooding alone. In addition, there would be an increased potential for loss of life due to the speed of onset and greater depth, extent, and velocity of flooding due to levee breach.

As previously mentioned, agricultural levees and levees that are not designed to provide flood protection from at least the 1-percent annual chance flood likely do exist in the planning area. However, none of these levees are shown on the Preliminary DFIRM, nor are they enrolled in the USACE Levee Safety Program. As a result, an inventory of these types of levees is not available for analysis. Additionally, since these types of levees do not provide protection from the 1-percent annual chance flood, losses associated with overtopping or failure are captured in the Flood Section

of this plan.

The USACE regularly inspects levees within its Levee Safety Program to monitor their overall condition, identify deficiencies, verify that maintenance is taking place, determine eligibility for federal rehabilitation assistance (in accordance with P.L. 84-99), and provide information about the levees on which the public relies. Inspection information also contributes to effective risk assessments and supports levee accreditation decisions for the National Flood Insurance Program administered by the Federal Emergency Management Agency (FEMA).

The USACE now conducts two types of levee inspections. Routine Inspection is a visual inspection to verify and rate levee system operation and maintenance. It is typically conducted each year for all levees in the USACE Levee Safety Program. Periodic Inspection is a comprehensive inspection led by a professional engineer and conducted by a USACE multidisciplinary team that includes the levee sponsor. The USACE typically conducts this inspection every five years on the federally authorized levees in the USACE Levee Safety Program.

Both Routine and Periodic Inspections result in a rating for operation and maintenance. Each levee segment receives an overall segment inspection rating of Acceptable, Minimally Acceptable, or Unacceptable. Figure 3.10 below defines the three ratings.

**Figure 3.20 Definitions of the Three Levee System Ratings**

<b>Levee System Inspection Ratings</b>	
<b>Acceptable</b>	All inspection items are rated as Acceptable.
<b>Minimally Acceptable</b>	One or more levee segment inspection items are rated as Minimally Acceptable or one or more items are rated as Unacceptable and an engineering determination concludes that the Unacceptable inspection items would not prevent the segment/system from performing as intended during the next flood event.
<b>Unacceptable</b>	One or more levee segment inspection items are rated as Unacceptable and would prevent the segment/system from performing as intended, or a serious deficiency noted in past inspections (previous Unacceptable items in a Minimally Acceptable overall rating) has not been corrected within the established timeframe, not to exceed two years.

The U.S. Army Corp of Engineers rated two (2) of the three (3) dams listed for Marion County as minimally acceptable and one (1) as acceptable. .

### **Previous Occurrences**

According to the US Army Corps of Engineers the Fabius River Levee in the far northeast corner of Marion County broke during the flood of 1993 resulting in the inundation of floodwater. The loss in farm production, homes and business in the West Quincy and Taylor areas was substantial. Over fifty homes, businesses and 14,000 acres of valuable farmland were totally inundated. In addition the loss of commerce with Quincy and the impact on 1800 Marion County residents who could no longer cross the bridge to their jobs in Illinois (commutes of 100 miles via Keokuk, Iowa became the norm) caused serious hardship. The loss of an entire planting season to the farmers in the West Quincy and Taylor areas the Flood of 1993 was financially devastating.

## Probability of Future Occurrence

According to the data researched during the last 22 years Marion County has only had one levee breach resulting in a low probability Marion County will have a levee breach in any given year. Due to a lack of a centralized database for Missouri levees the ability to obtain levee breach data is very limited.

## Vulnerability

### *Vulnerability Overview*

The analysis and discussion of vulnerability to levee failure in the planning area is for levees indicated as providing protection from 100-year or higher base flood level. Levees that provide protection from more frequent, lower-level flooding would overtop in a 100-year event; resulting loss estimates are captured in the discussion of vulnerability to riverine flooding in Section 3.4.6.

Levees have been constructed across the planning area by public entities and private entities with varying levels of protection, inspection oversight and maintenance. The National Levee Safety Program Act of 2007 directed the development of a national levee safety program, in addition to the inventory and inspection of levees. As discussed in Section 3.4.8, two concurrent nation-wide levee inventory development efforts led by USACE and FEMA have captured the majority of levees in the planning area, with the NLD focusing on the Corps' active PL84-99 program levees and the MLI focusing on levees that provide protection from 100-year or higher base flood level. In fall of 2012, USACE and FEMA conducted a pilot project to integrate the NLD and MLI levees for FEMA Region VII, which covers the entire State of Missouri. As a result of the pilot, Missouri now has a comprehensive levee GIS inventory that is spatially accurate and that reflects the best available information about levees from both federal agencies. This data will be used for high-level levee failure vulnerability analysis. Figure 3.9 is a summary of levee systems in the planning area known to provide protection from 100-year or higher base flood.

### *Potential Losses to Existing Development*

To determine the population and building count vulnerable to damage if these levee segments were to fail, the "Area Protected by Levees" feature class from the FEMA Midterm Levee Inventory was overlaid on census block –level buildings and population data from US Census 2010. As the vulnerability analysis of levee failure in this plan is limited to levees indicated as providing protection from 100-year or higher base flood level, protected area polygons were extracted for levees with a stated level of protection for the 100-year flood or greater. The overlay was performed using proportional division (so that if the levee protected area covers a fraction of a census block, that fraction of the building or population data is counted in the exposure), the building and contents value, building count and population exposure was calculated.

While the levee program has made extraordinary progress, there are still limitation and gaps in the data available. The study information for MO did not have inland levee protection information other than those listed on the major rivers. From this analysis, it was determined that the population at risk in the levee protected area is approximately 379 people. The residential building exposure count in the levee protected area is 297 and the building loss is \$24,309,551.

***Impact of Future Development***

Impact on future development in the planning area is directly related to the floodplain management and regulations set forth by Marion County and individuals through levee management and regulations which are not clearly defined. It is difficult to predict the impact on future development due to most private levees are not regulated or inspected by one agency or on a regular basis. Any new construction that falls in the floodplain will have to adhere to Marion County's construction and zoning regulations and must adhere to those regulations.

***Summary by Jurisdiction***

Structures located in the downtown Hannibal area would be vulnerable to the effects of a levee failure along the Mississippi River. The downtown area would experience devastating flooding, substantial business losses and residents in the immediate area would be highly impacted.

The City of Taylor is protected by a levee the breached during the 1993 and if this occurred again the same devastating flooding would be experienced.

**Problem Statement**

The planning area is at a higher risk than other areas due to the Mississippi River boarding the area, not all residents understand the dangers associated with a levee breach, if the City of Hannibal levee broke there would be substantial loss for Hannibal and the Fabius levee could breach again causing substantial damages.

Residents and businesses need to be more informed about the dangers of a levee breach and have a plan in place in the event of a levee breach.

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### 3.4.9 Thunderstorm/High Winds/Lightning/Hail

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#### Hazard Profile

#### Hazard Description

##### *Thunderstorms*

A thunderstorm is defined as a storm that contains lightning and thunder which is caused by unstable atmospheric conditions. When cold upper air sinks and warm moist air rises, storm clouds or 'thunderheads' develop resulting in thunderstorms. This can occur singularly, as well as in clusters or lines. The National Weather Service defines a thunderstorm as "severe" if it includes hail that is one inch or more, or wind gusts that are at 58 miles per hour or higher. At any given moment across the world, there are about 1,800 thunderstorms occurring. Severe thunderstorms most often occur in Missouri in the spring and summer, during the afternoon and evenings, but can occur at any time. Other hazards associated with thunderstorms are heavy rains resulting in flooding (discussed separately in Section 3.4.6) and tornadoes (discussed separately in Section 3.4.10).

##### *High Winds*

A severe thunderstorm can produce winds causing as much damage as a weak tornado. The damaging winds of thunderstorms include downbursts, microbursts, and straight-line winds. Downbursts are localized currents of air blasting down from a thunderstorm, which induce an outward burst of damaging wind on or near the ground. Microbursts are minimized downbursts covering an area of less than 2.5 miles across. They include a strong wind shear (a rapid change in the direction of wind over a short distance) near the surface. Microbursts may or may not include precipitation and can produce winds at speeds of more than 150 miles per hour. Damaging straight-line winds are high winds across a wide area that can reach speeds of 140 miles per hour.

##### *Lightning*

All thunderstorms produce lightning which can strike outside of the area where it is raining and has been known to fall more than 10 miles away from the rainfall area. Thunder is simply the sound that lightning makes. Lightning is a huge discharge of electricity that shoots through the air causing vibrations and creating the sound of thunder.

##### *Hail*

According to the National Oceanic and Atmospheric Administration (NOAA), hail is precipitation that is formed when thunderstorm updrafts carry raindrops upward into extremely cold atmosphere causing them to freeze. The raindrops form into small frozen droplets. They continue to grow as they come into contact with super-cooled water which will freeze on contact with the frozen rain droplet. This frozen droplet can continue to grow and form hail. As long as the updraft forces can support or suspend the weight of the hailstone, hail can continue to grow before it hits the earth.

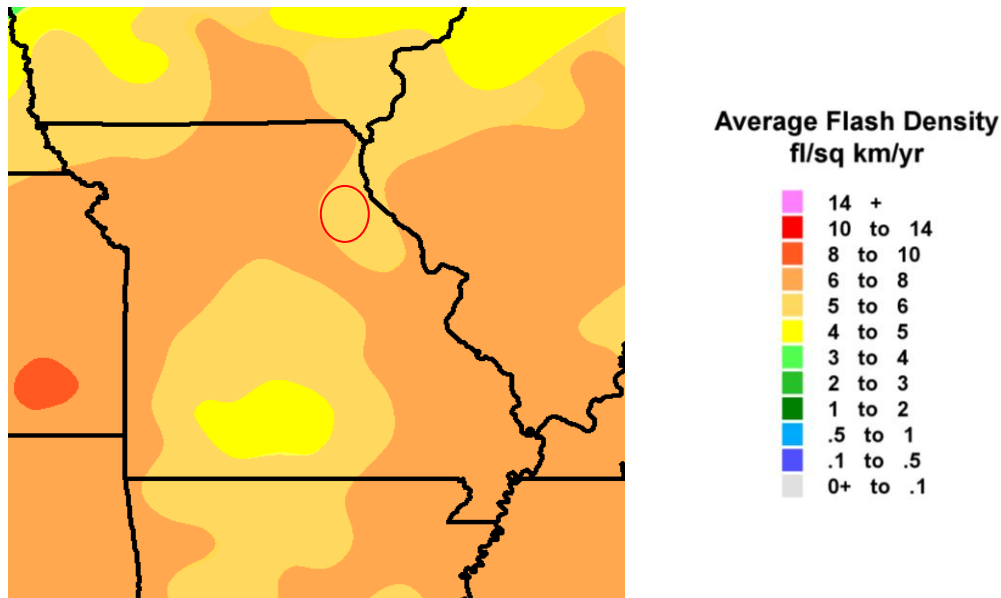
At the time when the updraft can no longer support the hailstone, it will fall down to the earth. For example, a 1/4" diameter or pea sized hail requires updrafts of 24 miles per hour, while a 2 3/4" diameter or baseball sized hail requires an updraft of 81 miles per hour. According to the NOAA, the

largest hailstone in diameter recorded in the United States was found in Vivian, South Dakota on July 23, 2010. It was eight inches in diameter, almost the size of a soccer ball. Soccer-ball-sized hail is the exception, but even small pea-sized hail can do damage.

### Geographic Location

All of Marion County is susceptible to thunderstorms/high winds/hail and lightning events. Although these events occur similarly throughout the planning area, they are more frequently reported in more urbanized areas. In addition, damages are more likely to occur in more densely developed urban areas.

**Figure 3.27 Location and Frequency of Lightning in Missouri**

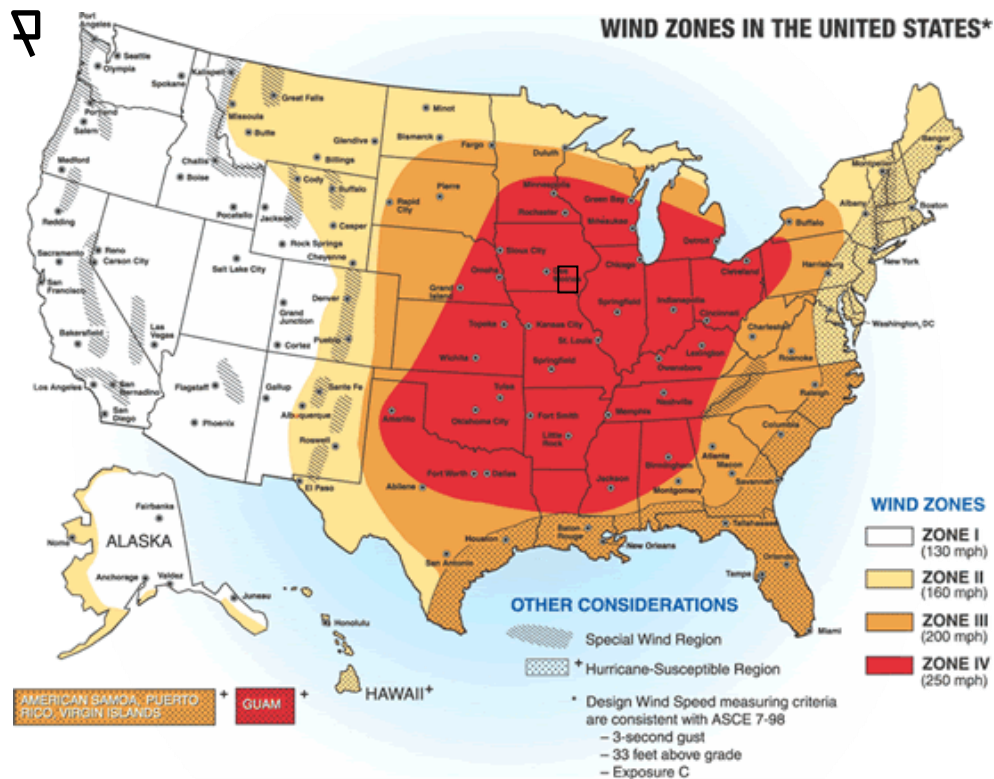


Source: National Weather Service,  
[http://www.lightningsafety.noaa.gov/stats/08\\_Vaisala\\_NLDN\\_Poster.pdf](http://www.lightningsafety.noaa.gov/stats/08_Vaisala_NLDN_Poster.pdf).  
 Note: Red circle indicates approximate location of Marion County.

All of Marion County is susceptible to high wind events. Marion County is located in Wind Zone IV, which is susceptible to winds up to 250 mph. All of the participating jurisdictions are vulnerable to this hazard. Figure 3.12 shows the wind zones of the United States based on maximum wind speeds; the entire state of Missouri is located in wind zone IV, the highest inland categories.



Figure 3.21 Wind Zones in the United States



Source: FEMA 320, Taking Shelter from the Storm, 3rd edition, [http://www.weather.gov/media/bis/FEMA\\_SafeRoom.pdf](http://www.weather.gov/media/bis/FEMA_SafeRoom.pdf)

### Severity/Magnitude/Extent

Severe thunderstorm losses are usually attributed to the associated hazards of hail, downburst winds, lightning and heavy rains. Losses due to hail and high wind are typically insured losses that are localized and do not result in presidential disaster declarations. However, in some cases, impacts are severe and widespread and assistance outside state capabilities is necessary. Hail and wind also can have devastating impacts on crops. Severe thunderstorms/heavy rains that lead to flooding are discussed in the flooding hazard profile. Hailstorms cause damage to property, crops, and the environment, and can injure and even kill livestock. In the United States, hail causes more than \$1 billion in damage to property and crops each year. Even relatively small hail can shred plants to ribbons in a matter of minutes. Vehicles, roofs of buildings and homes, and landscaping are also commonly damaged by hail. Hail has been known to cause injury to humans, occasionally fatal injury.

In general, assets in the County vulnerable to thunderstorms with lightning, high winds, and hail include people, crops, vehicles, and built structures. Although this hazard results in high annual losses, private property insurance and crop insurance usually cover the majority of losses. Considering insurance coverage as a recovery capability, the overall impact on jurisdictions is reduced.

Most lightning damages occur to electronic equipment located inside buildings. But structural damage can also occur when a lightning strike causes a building fire. In addition, lightning strikes can cause damages to crops if fields or forested lands are set on fire. Communications equipment and warning transmitters and receivers can also be knocked out by lightning strikes. [http://www.lightningsafety.noaa.gov/stats/08\\_Vaisala\\_NLDN\\_Poster.pdf](http://www.lightningsafety.noaa.gov/stats/08_Vaisala_NLDN_Poster.pdf) and <http://www.lightningsafety.noaa.gov/>

Based on information provided by the Tornado and Storm Research Organization (TORRO), Table 3.28 below describes typical damage impacts of the various sizes of hail.

**Table 3.29 Tornado and Storm Research Organization Hailstorm Intensity Scale**

Intensity Category	Diameter (mm)	Diameter (inches)	Size Description	Typical Damage Impacts
Hard Hail	5-9	0.2-0.4	Pea	No damage
Potentially Damaging	10-15	0.4-0.6	Mothball	Slight general damage to plants, crops
Significant	16-20	0.6-0.8	Marble, grape	Significant damage to fruit, crops, vegetation
Severe	21-30	0.8-1.2	Walnut	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
Severe	31-40	1.2-1.6	Pigeon's egg > squash ball	Widespread glass damage, vehicle bodywork damage
Destructive	41-50	1.6-2.0	Golf ball > Pullet's egg	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
Destructive	51-60	2.0-2.4	Hen's egg	Bodywork of grounded aircraft dented, brick walls pitted
Destructive	61-75	2.4-3.0	Tennis ball > cricket ball	Severe roof damage, risk of serious injuries
Destructive	76-90	3.0-3.5	Large orange > Soft ball	Severe damage to aircraft bodywork
Super Hailstorms	91-100	3.6-3.9	Grapefruit	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
Super Hailstorms	>100	4.0+	Melon	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open

Source: Tornado and Storm Research Organization (TORRO), Department of Geography, Oxford Brookes University

Notes: In addition to hail diameter, factors including number and density of hailstones, hail fall speed and surface wind speeds affect severity. <http://www.torro.org.uk/site/hyscale.php>

Straight-line winds are defined as any thunderstorm wind that is not associated with rotation (i.e., is not a tornado). It is these winds, which can exceed 100 miles per hour, which represent the most common type of severe weather. They are responsible for most wind damage related to thunderstorms. Since thunderstorms do not have narrow tracks like tornadoes, the associated wind damage can be extensive and affect entire (and multiple) counties. Objects like trees, barns, outbuildings, high-profile vehicles, and power lines/poles can be toppled or destroyed, and roofs, windows, and homes can be damaged as wind speeds increase.

The tables below (Tables 3.28 through Table 3.30) summarize past crop damages as indicated by crop insurance claims. The tables illustrate the magnitude of the impact on the planning area's agricultural economy. The information obtained from the Risk Management Agency website did not indicate crop payments for thunderstorms.

**Table 3.30 Crop Insurance Claims Paid in Marion County from High Winds, 2005 - 2015**

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2005	Corn	Wind	\$9,777
2007	Corn	Wind	\$13,057
2007	Corn	Wind	\$16,746
2008	Corn	Wind	\$3,197
2011	Corn	Hot Wind	\$5,201
2011	Corn	Wind/Excess Wind	\$10,452
2013	Corn	Wind/Excess Wind	\$14,320
2013	Corn	Wind/Excess Wind	\$11,447
Total			\$84,197

Source: USDA Risk Management Agency, Insurance Claims, <http://www.rma.usda.gov/data/cause.htm>

**Table 3.31 Crop Insurance Claims Paid in Marion County from Lightning, 2005 - 2015**

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2010	Grain Sorghum	Other Possible Lightning	\$7,417
2012	Soybeans	Other Possible Lightning	\$2,033
Total			\$9,450

USDA Risk Management Agency, Insurance Claims, <http://www.rma.usda.gov/data/cause.htm>

**Table 3.31 Crop Insurance Claims Paid in Marion County from Hail, 2005 - 2015**

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2005	Corn	Hail	\$446
2011	Wheat	Hail	\$5,198
2011	Wheat	Hail	\$576
2011	Wheat	Hail	\$1,637
2011	Corn	Hail	\$1,102
2011	Soybeans	Hail	\$4,827
2013	Corn	Hail	\$14,320
2013	Corn	Hail	\$11,447
Total			\$39,553

USDA Risk Management Agency, Insurance Claims, <http://www.rma.usda.gov/data/cause.htm>

### ***Agricultural Impacts***

Severe thunderstorms can take a toll on crop production in the planning area. According to the USDA's Risk Management Agency, there have not been any payments for insured crop losses specifically for thunderstorms but payments have been made for the associated flooding, hail and wind.

The onset of thunderstorms with lightning, high wind, and hail is generally rapid. Duration is less than six hours and warning time is generally six to twelve hours. Nationwide, lightning kills 75 to 100 people each year. Lightning strikes can also start structural and wildland fires, as well as damage electrical systems and equipment.

## Previous Occurrences

The three tables below include NCDC reported events and damages for the past 10 years for thunderstorms, hail and lightning. There was no data available for high wind for the 10 year period reviewed.

**Table 3.32 Reported Events and Damages In Marion County from Thunderstorms, 2005 – 2015 Events Summarized by Magnitude**

Wind Magnitude	Number of Events	Property Damages	Crop Damages
50 -55	20	\$0	\$0
56- 60	10	\$0	\$0
61- 65	4	\$0	\$0
66- 70	1	\$0	\$0
71 – 75	0	\$0	\$0
76 +	2	\$100K	\$0

**June 18, 2011-** Thunderstorm winds blew a mobile home off its foundation and destroyed it. Three people were in the mobile home at the time, two adults and one infant. All three suffered only minor injuries.

**May 20, 2015-** A line of severe thunderstorms moved through Hannibal. The storms caused considerable wind damage in and around Hannibal. The damage area was roughly from Highway MM north to Hannibal-LaGrange University. One building at the university had a small portion of its roof torn off. Numerous trees were either uprooted or snapped along Palmyra Road/Mark Twain Avenue. A three story brick building in downtown Hannibal on Main Street had a wall collapse and about half its roof torn off. Wind gusts in this area were likely around 100 mph. Tree damage was common west of the downtown area to U.S. Highway 61 and then west of U.S. Highway 61 along West Ely Road. The subdivisions around Pioneer Lake and Apollo Lake had numerous large tree branches blown down. One home near Apollo Lake had windows broken by flying debris. A small building lost part of its roof on the south side of Hannibal on Market Street.

**Table 3.33 Hail Events Summarized by Hail Size in Marion County, 2005 - 2015**

Hail Size (inches)	Number of Events	Property Damages	Crop Damages
.75	26	\$0	\$0
1.00	16	\$0	\$0
1.50	5	\$1,000M	\$0
2.00	1	\$0	\$0

**May 13, 2008-** Hail up to golf ball size fell on Hannibal. Most of the large hail fell on the south part of town. About 200 cars in a manufacturing company parking lot were damaged.

**Table 3.34 Lightning Events In Marion County, 2005 - 2015**

<b>Date of Lightning</b>	<b>Number of Events</b>	<b>Property Damage</b>	<b>Crop Damages</b>
08/26/2006	1	\$25K	\$0
09/21/2010	1	\$0	\$0

The National Centers for Environmental Information did not report any high wind events for Marion County for the 10 years looked at.

### ***Probability of Future Occurrence***

#### ***Thunderstorms***

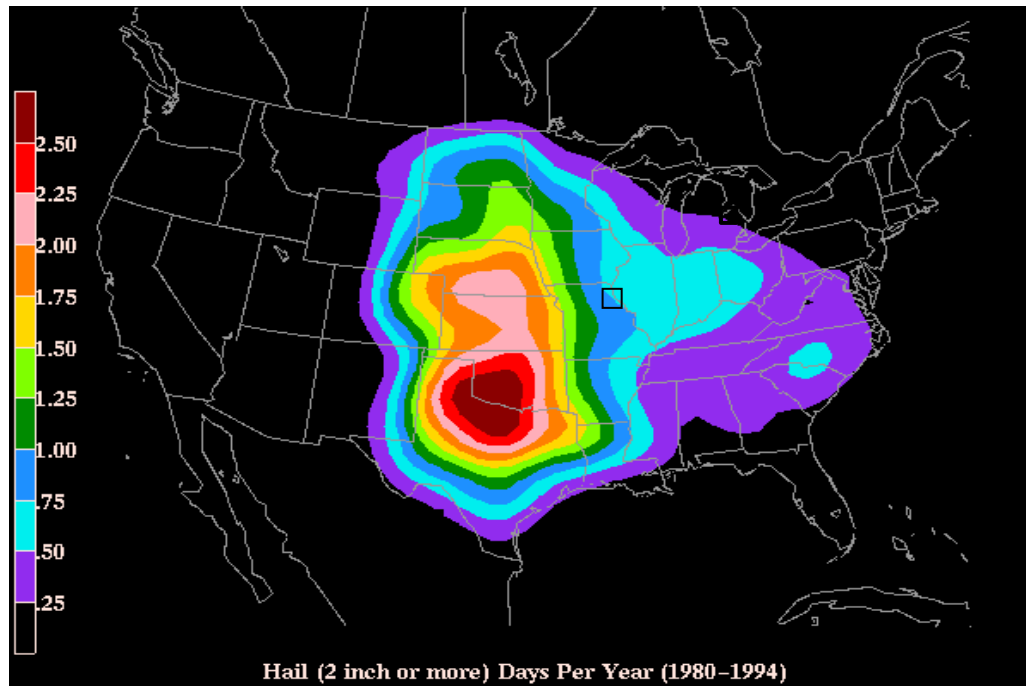
High wind events 50 knots and greater occurred an average of 1.48 times per year in the planning area from 1965 to 2015. Reported lightning events only occurred 2 times from 2005 to 2015, but since lightning accompanies thunderstorms, it can be assumed that lightning occurs more often than reported. These rates occurrence are expected to continue in the future.

#### ***Hail***

Based on this data, there have been 48 events in a 10 year period, producing an average of 4.8 hail events each year in Marion County. When limiting the probability analysis to hail events producing hail 1.50 inches and larger, there have been 6 events in a 10 year period. Based on this history, the probability of a destructive hail event in any given year is 60 percent. Thus making the probability as likely in any given year.

Figure 3.22 is based on hailstorm data from 1980-1994. It shows the probability of hailstorm occurrence (2" diameter or larger) based on number of days per year. Marion County is located in the region to receive between .75 and 1 hailstorms annually.



**Figure 3.22 Annual Hailstorm Probability (2" diameter or larger), U 1980- 1994**

Source: NSSL, [http://www.nssl.noaa.gov/users/brooks/public\\_html/bighail.gif](http://www.nssl.noaa.gov/users/brooks/public_html/bighail.gif) Note:

## **Vulnerability**

### ***Vulnerability Overview***

In general, assets in the planning area that are vulnerable to hail (.75 inches in diameter in larger), thunderstorm and lightning damage include people, crops, vehicles, and built structures. According to the 2010 Missouri Hazard Mitigation Plan the Marion County annualized hail damages are \$63,244.45, lightning damages are \$1,680.00 and thunderstorm damages are \$79,605.00

### ***Potential Losses to Existing Development***

#### ***Thunderstorms and Lightning***

Most damages occur to electronic equipment located inside buildings, but structural damage can also occur when a lightning strike causes a building fire. Communications equipment and warning transmitters and receivers can also be knocked out by lightning strikes. There has not been any fatalities and only 1 injury due to lightning in Marion County during the 10 year period reviewed. Thunderstorms and lightning contributed to approximately \$125,000 in damages with an annualize cost of \$12,500.00.

#### ***Hail***

The estimated annualized property damages resulting from hail is \$100,000. This amount does not take in account most buildings and structures that are privately insured thus insurance would help the building owner recover from hail damage.

#### ***High Winds***

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During the 10 year period reviewed there was no damage contributed to high winds. When the review period is extended to the last 65 years there is still no reported damage due to high winds reported for Marion County.

### ***Future Development***

Marion County's current trend in increased development will likely increase vulnerability to thunderstorms, high winds, hail and lightning. With more development of housing neighborhoods and businesses, the increased population will be vulnerable to all of the hazards.

### ***Hazard Summary by Jurisdiction***

Thunderstorms/high winds/lightning/hail events are area-wide, NCDC data did not seem to indicate that any particular community had significantly higher losses as compared to another. The City of Hannibal is the largest and has the most houses constructed prior to 1939.

### ***Problem Statement***

Thunderstorms can damage power lines with the high winds or fallen debris such as tree limbs, Not everyone in the county utilizes social media, texting or have access to a weather radio, smaller communities do not have warning sirens, rural areas do not have warning sirens, Marion County has several mobile home parks that makes them more vulnerable, agricultural land is often damaged by thunderstorms and damage occurs to residential and commercial structure.

Possible solutions could be the installation of warning sirens in smaller communities, rural citizens are educated on the utilizing social media and texting, warning sirens are installed in mobile home parks and weather radios are accessed by residents more than currently being used.

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### 3.4.10 Tornado

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#### Hazard Profile

##### *Hazard Description*

The NWS defines a tornado as “a violently rotating column of air extending from a thunderstorm to the ground.” It is usually spawned by a thunderstorm and produced when cool air overrides a layer of warm air, forcing the warm air to rise rapidly. Often, vortices remain suspended in the atmosphere as funnel clouds. When the lower tip of a vortex touches the ground, it becomes a tornado.

High winds not associated with tornadoes are profiled separately in this document in Section 3.4.9, Thunderstorm/High Wind/Hail/Lightning.

Essentially, tornadoes are a vortex storm with two components of winds. The first is the rotational winds that can measure up to 500 miles per hour, and the second is an uplifting current of great strength. The dynamic strength of both these currents can cause vacuums that can overpressure structures from the inside.

Although tornadoes have been documented in all 50 states, most of them occur in the central United States due to its unique geography and presence of the jet stream. The jet stream is a high-velocity stream of air that separates the cold air of the north from the warm air of the south. During the winter, the jet stream flows west to east from Texas to the Carolina coast. As the sun moves north, so does the jet stream, which at summer solstice flows from Canada across Lake Superior to Maine. During its move northward in the spring and its recession south during the fall, the jet stream crosses Missouri, causing the large thunderstorms that breed tornadoes.

A typical tornado can be described as a funnel-shaped cloud in contact with the earth’s surface that is “anchored” to a cloud, usually a cumulonimbus. This contact on average lasts 30 minutes and covers an average distance of 15 miles. The width of the tornado (and its path of destruction) is usually about 300 yards. However, tornadoes can stay on the ground for upward of 300 miles and can be up to a mile wide. The National Weather Service, in reviewing tornadoes occurring in Missouri between 1950 and 1996, calculated the mean path length at 2.27 miles and the mean path area at 0.14 square mile.

The average forward speed of a tornado is 30 miles per hour but may vary from nearly stationary to 70 miles per hour. The average tornado moves from southwest to northeast, but tornadoes have been known to move in any direction. Tornadoes are most likely to occur in the afternoon and evening, but have been known to occur at all hours of the day and night.

##### *Geographic Location*

Tornadoes can occur in the entire planning area. Information obtained in the FEMA 320, Taking Shelter from the Storm, 3<sup>rd</sup> edition which records the number of F3, F4, and F5 tornadoes recorded in the United States during a 57- year period indicates 5 – 10 tornadoes of this magnitude occurred in planning area.

**Severity/Magnitude/Extent**

Tornadoes are the most violent of all atmospheric storms and are capable of tremendous destruction. Wind speeds can exceed 250 miles per hour and damage paths can be more than one mile wide and 50 miles long. Tornadoes have been known to lift and move objects weighing more than 300 tons a distance of 30 feet, toss homes more than 300 feet from their foundations, and siphon millions of tons of water from water bodies. Tornadoes also can generate a tremendous amount of flying debris or “missiles,” which often become airborne shrapnel that causes additional damage. If wind speeds are high enough, missiles can be thrown at a building with enough force to penetrate windows, roofs, and walls. However, the less spectacular damage is much more common.

Tornado magnitude is classified according to the EF- Scale (or the Enhanced Fujita Scale, based on the original Fujita Scale developed by Dr. Theodore Fujita, a renowned severe storm researcher). The EF- Scale (see **0**) attempts to rank tornadoes according to wind speed based on the damage caused. This update to the original F Scale was implemented in the U.S. on February 1, 2007.

**Table 3.35 Enhanced F Scale for Tornado Damage**

FUJITA SCALE			DERIVED EF SCALE		OPERATIONAL EF SCALE	
F Number	Fastest ¼-mile (mph)	3 Second Gust (mph)	EF Nu	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

Source: The National Weather Service, [www.spc.noaa.gov/faq/tornado/ef-scale.html](http://www.spc.noaa.gov/faq/tornado/ef-scale.html)

The wind speeds for the EF scale and damage descriptions are based on information on the NOAA Storm Prediction Center as listed in Table 3.35. The damage descriptions are summaries. For the actual EF scale it is necessary to look up the damage indicator (type of structure damaged) and refer to the degrees of damage associated with that indicator. Information on the Enhanced Fujita Scale’s damage indicators and degrees of damage is located online at [www.spc.noaa.gov/efscale/ef-scale.html](http://www.spc.noaa.gov/efscale/ef-scale.html).

**Table 3.36 Enhanced Fujita Scale with Potential Damage**

Enhanced Fujita Scale			
Scale	Wind Speed (mph)	Relative Frequency	Potential Damage
EF0	65-85	53.5%	Light. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e. those that remain in open fields) are always rated EF0).
EF1	86-110	31.6%	Moderate. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	10.7%	Considerable. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes complete destroyed; large trees snapped or uprooted; light object missiles generated; cars lifted off ground.
EF3	136-165	3.4%	Severe. Entire stores of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some
EF4	166-200	0.7%	Devastating. Well-constructed houses and whole frame houses completely levelled; cars thrown and small missiles generated.
EF5	>200	<0.1%	Explosive. Strong frame houses levelled off foundations and swept away; automobile-sized missiles fly through the air in excess of 300 ft.; steel reinforced concrete structure badly damaged; high rise buildings have significant structural deformation; incredible phenomena will occur.

Source: NOAA Storm Prediction Center, <http://www.spc.noaa.gov/efscale/ef-scale.html>

Enhanced weather forecasting has provided the ability to predict severe weather likely to produce tornadoes days in advance. Tornado watches can be delivered to those in the path of these storms several hours in advance. Lead time for actual tornado warnings is about 30 minutes. Tornadoes have been known to change paths very rapidly, thus limiting the time in which to take shelter. Tornadoes may not be visible on the ground if they occur after sundown or due to blowing dust or driving rain and hail.

### ***Previous Occurrences***

There are limitations to the use of NCDC tornado data that must be noted. For example, one tornado may contain multiple segments as it moves geographically. A tornado that crosses a county line or state line is considered a separate segment for the purposes of reporting to the NCDC. Also, a tornado that lifts off the ground for less than 5 minutes or 2.5 miles is considered a separate segment. If the tornado lifts off the ground for greater than 5 minutes or 2.5 miles, it is considered a separate tornado. Tornadoes reported in Storm Data and the Storm Events Database are in segments.

According to statistics reported by the National Climatic Data Center, Marion County has experienced 9 tornadoes from 1950 to 2015 (listings on the same date more than one hour apart or at different locations were considered multiple events). Of these 1 was an F3, 1 was an F2, 2 were F1 and 5 were F0. These tornadoes caused a combined 1 injury and over \$400K in damages. There were no reported crop damages from tornadoes. Table 3.37 summarizes these events.

**Table 3.37 Recorded Tornadoes in Marion County, 1993 – Present**

Date	Beginning Location	Ending Location	Length (miles)	Width (yards)	F/EF Rating	Death	Injury	Property Damage	Crop Damages
5/10/2003	1SW ELY	4SSE PALMYRA	9.5	200	F3	0	0	0	0
5/24/2004	6NW HANNIBAL	4NW HANNIBAL	2	50	F0	0	0	0	0
10/02/2007	5W ELY	4W ELY	1.2	50	F0	0	0	0	0
10/02/2007	1E WOODLAND	2SSE PALMYRA	3.79	100	F1	0	0	\$100,000	0
10/02/2007	0SW PALMYRA	0E PALMYRA	.7	60	F0	0	0	\$50,000	0
10/02/2007	3NNW HANNIBAL MUNI ARPT	2WSW HELTON	.51	40	F0	0	0	0	0
5/20/2013	2ENE WHITE BEAR	2SSE HANNIBAL MUNI ARPT	1.16	50	F1	0	0	0	0

Source: National Climatic Data Center, <http://www.ncdc.noaa.gov/stormevents/>

**May 10, 2003--** After crossing the extreme northwest corner of Ralls County, the second tornado from the Monroe County supercell crossed back into Marion County southwest of Ely. Approximately one mile north of Ely, three farmsteads sustained varying degrees of damage including damaged or destroyed machine sheds, grain bins, and barns. The garage attached to a home one mile north of Ely was completely destroyed while the farm house sustained roof and side damage and was moved off its foundation. A relatively new home 200 yards to the east experienced severe damage with the roof of the home tossed over 1/3 mile to the northeast. Much of the south, and parts of the east and west walls of the home were destroyed. A nearby barn located 30 yards to the northwest was completely destroyed with debris tossed 1/4 mile to the north-northeast. Several two-by-four wood planks were driven into the ground at 45 to 60 degree angles and were located from 50 to 150 yards downwind from the home. The damage intensity over these areas were rated high-end F2 and low-end F3. The width of the damage area was over 200 yards. The tornado continued on a northeast path and damaged several machine sheds and homes on two additional farmsteads northwest of the town of West Ely (or 7-8 miles south-southwest of Palmyra Missouri). Numerous trees were damaged or destroyed in the path of the tornado. The width of the damage varied from 50 to 100 yards while the damage area was rated F1. The tornado traveled across U.S. Highway 61/24 and dissipated about four miles south southeast of Palmyra. One semi-tractor trailer was overturned on Highway 61/24. The damage path of the tornado at this point was less than 50 yards and rated F0 intensity.



**Figure 3.23 Marion County Map of Historic Tornado Events****Path of May 3, 2010 Tornado in Marion County**

Source: <http://www.tornadohistoryproject.com/tornado/20030510.29.87>

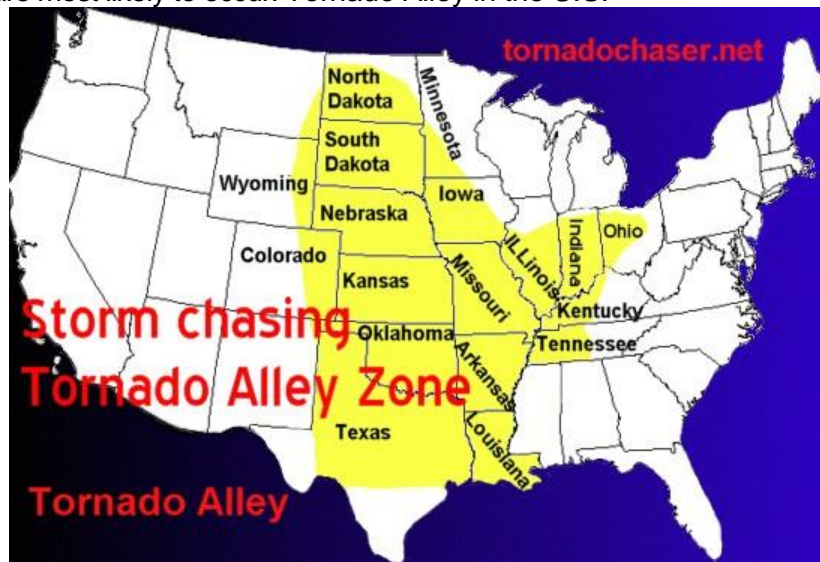
During the previous 23 years of data from the USDA Risk Management Agency Marion County has not received any insurance payments for crop damages as a result of tornadoes.

***Probability of Future Occurrence***

The National Climatic Data Center reported 9 tornadoes in Marion County in a 65-year time period, which calculates to 14 percent chance of a tornado in any given year. Therefore it is a low probability that some portion of Marion County will experience tornado activity in any given year.

**Vulnerability****Vulnerability Overview**

Marion County is located in a region of the U. S. with high frequency of dangerous and destructive tornadoes referred to as “Tornado Alley”. Figure 3.15 is based on areas where dangerous tornadoes are most likely to occur. Tornado Alley in the U.S.



Source: <http://www.tornadochaser.net/tornalley.html>

According to the Missouri Hazard Mitigation Plan, there is 12 reported tornadoes for the same time period as stated in the plan this is due to tornadoes being combined. The likelihood of Occurrence is increased by 5% making a total vulnerability rating of moderate. This vulnerability analysis measured the likelihood of future tornado impacts based on past occurrences value divided by the number of years reviewed to factor out a rating.

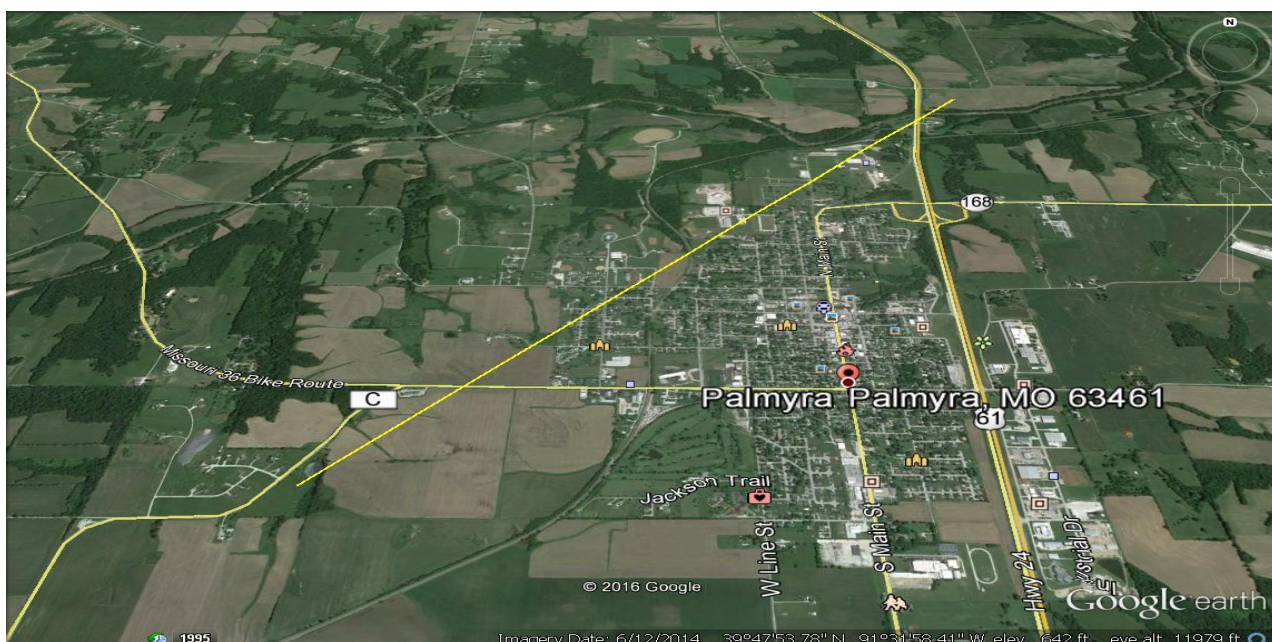
The approach to the 2015 Marion County Hazard Mitigation Plan included an update of the tornado occurrences since 2010.

### ***Potential Losses to Existing Development***

In Marion County, the NCEM estimate for past damages from 1950 to 2015 is \$400,000 and the annualized property damage is \$6,153 over the 65 years.

To estimate vulnerability to tornadoes, the MPC decided to consider the impacts of an F1/EF1 tornado due to this being the second most common in the period reviewed tornado with wind speed of approximately 100 mph and a length of 3 miles and width of 100 yards in the County, The location chosen is based on medium housing and commercial structure density to show the variance of potential damages. Based on information from the NOAA Storm Prediction Center, a F1/EF1 tornado of this magnitude would severely strip roofs, mobile homes overturned or badly damaged, loss of exterior doors and window and other glass broken. Several factors impact the severity of damage, including wind speed, time on the ground, length/width of the cell, population density, building density, age and construction of buildings and time of day.

**Scenario: Palmyra, MO.** The F1/EF1 tornado starts in a rural area of Marion County approximately 1 mile from the city limits of Palmyra. The tornado moves in a northeast direction hitting a mobile home park with 15 units and moving into the northwest part of Palmyra and misses the downtown district. There will be approximately 75 buildings in the tornado path and those buildings would sustain over 1 million in damages from the tornado.



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***Future Development***

Due to the growth in Marion County, development trends are anticipated to increase vulnerability to tornadoes. When Hannibal, Palmyra and New London experiences future development planning, engineering and architectural design stages should be considered to protect against tornadoes. Future development for public buildings such as schools, government offices, as well as buildings with high occupancy and mobile home parks should consider including a tornado saferoom to protect occupants in the event of a tornado. Marion County is known for a number of parks and as these are expanded future considerations should be made to shelter people using the parks.

***Hazard Summary by Jurisdiction***

Tornadoes can occur in the entire planning area however due to the age of housing, age of commercial structures and a high concentration of mobile homes throughout the county some of the jurisdictions would suffer heavier damages. No damage to schools or special district assets from previous tornado occurrences was indicated on the Data Collection Questionnaire.

**Problem Statement**

Marion County has inadequate tornado shelters throughout the county, not everyone utilizes social media and/or texting, the rural areas do not have warning sirens, smaller communities do not have warning sirens, lack of awareness for available shelters and more education needs to occur.

The City of Hannibal has 1 FEMA certified tornado shelter that is owned and operated by Moberly Area Community College with 2 Tornado Shelter Alternatives at local churches. Possible solutions could be awareness made of existing tornado shelters, education on what to do in the event of a tornado and smaller communities could install warning sirens. A strong emphasis could be made for everyone in the county to own a weather radio.

### 3.4.11 Winter Weather/Snow/Ice/Severe Cold

#### Hazard Profile

##### *Hazard Description*

A major winter storm can last for several days and be accompanied by high winds, freezing rain or sleet, heavy snowfall, and cold temperatures. The National Weather Service describes different types of winter storm events as follows.

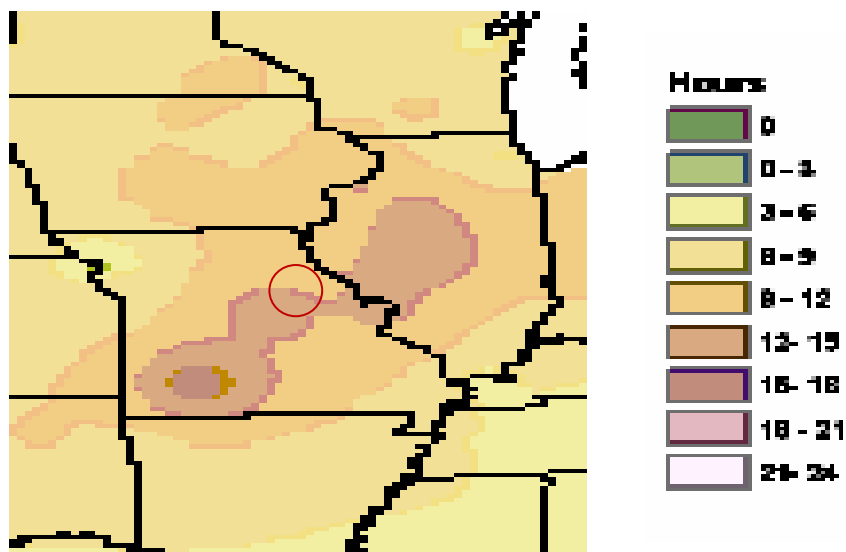
- **Blizzard**—Winds of 35 miles per hour or more with snow and blowing snow reducing visibility to less than  $\frac{1}{4}$  mile for at least three hours.
- **Blowing Snow**—Wind-driven snow that reduces visibility. Blowing snow may be falling snow and/or snow on the ground picked up by the wind.
- **Snow Squalls**—Brief, intense snow showers accompanied by strong, gusty winds. Accumulation may be significant.
- **Snow Showers**—Snow falling at varying intensities for brief periods of time. Some accumulation is possible.
- **Freezing Rain**—Measurable rain that falls onto a surface with a temperature below freezing. This causes it to freeze to surfaces, such as trees, cars, and roads, forming a coating or glaze of ice. Most freezing-rain events are short lived and occur near sunrise between the months of December and March.
- **Sleet**—Rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects.

##### *Geographic Location*

The entire Marion County is vulnerable to heavy snow, extreme temperatures and freezing rain. The snow season normally extends from late November through mid-March but significant snows have fallen as early as November 24 (2004) to as late as April 10 (1997).

Figure 3.24 shows that the entire planning area (approximated within the red circle) is in the orange-shaded area that receives 9-12 hours of freezing rain a year.

**Figure 3.24 NWS Statewide Average Number of Hours per Year with Freezing Rain**





Source: American Meteorological Society. "Freezing Rain Events in the United States." <http://ams.confex.com/ams/pdfpapers/71872.pdf>

### ***Severity/Magnitude/Extent***

Severe winter storms include extreme cold, heavy snowfall, ice, and strong winds which can push the wind chill well below zero degrees in the planning area. Heavy snow can bring a community to a standstill by inhibiting transportation (in whiteout conditions), weighing down utility lines, and by causing structural collapse in buildings not designed to withstand the weight of the snow. Repair and snow removal costs can be significant. Ice buildup can collapse utility lines and communication towers, as well as make transportation difficult and hazardous. Ice can also become a problem on roadways if the air temperature is high enough that precipitation falls as freezing rain rather than snow.

Extreme cold often accompanies severe winter storms and can lead to hypothermia and frostbite in people without adequate clothing protection. Cold can cause fuel to congeal in storage tanks and supply lines, stopping electric generators. Cold temperatures can also overpower a building's heating system and cause water and sewer pipes to freeze and rupture. Extreme cold also increases the likelihood for ice jams on flat rivers or streams. When combined with high winds from winter storms, extreme cold becomes extreme wind chill, which is hazardous to health and safety.

The National Institute on Aging estimates that more than 2.5 million Americans are elderly and especially vulnerable to hypothermia, with the isolated elders being most at risk. About 10 percent of people over the age of 65 have some kind of bodily temperature-regulating defect, and 3-4 percent of all hospital patients over 65 are hypothermic.

Also at risk are those without shelter, those who are stranded, or who live in a home that is poorly insulated or without heat. Other impacts of extreme cold include asphyxiation (unconsciousness or death from a lack of oxygen) from toxic fumes from emergency heaters; household fires, which can be caused by fireplaces and emergency heaters; and frozen/burst pipes.

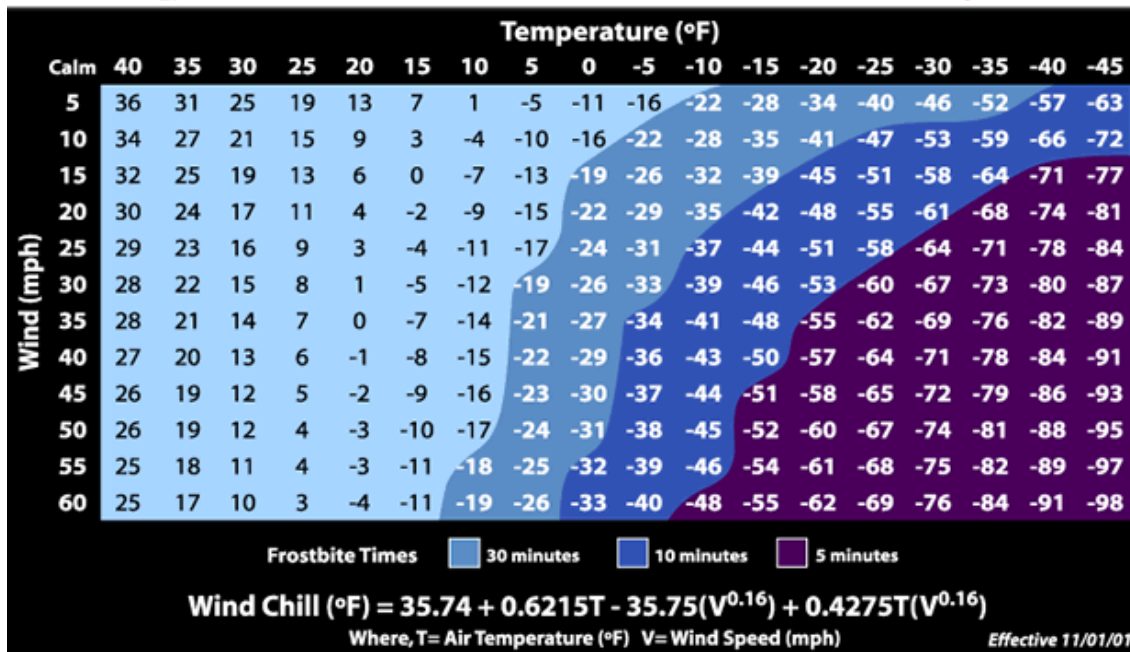
Buildings with overhanging tree limbs are more vulnerable to damage during winter storms when limbs fall. Businesses experience loss of income as a result of closure during power outages. In general heavy winter storms increase wear and tear on roadways though the cost of such damages is difficult to determine. Businesses can experience loss of income as a result of closure during winter storms.

Overhead power lines and infrastructure are also vulnerable to damages from winter storms. In particular ice accumulation during winter storm events damage to power lines due to the ice weight on the lines and equipment. Damages also occur to lines and equipment from falling trees and tree limbs weighted down by ice. Potential losses could include cost of repair or replacement of damaged facilities, and lost economic opportunities for businesses.

Secondary effects from loss of power could include burst water pipes in homes without electricity during winter storms. Public safety hazards include risk of electrocution from downed power lines. Specific amounts of estimated losses are not available due to the complexity and multiple variables associated with this hazard. Standard values for loss of service for utilities reported in FEMA's 2009 BCA Reference Guide, the economic impact as a result of loss of power is \$126 per person per day of lost service.

Wind can greatly amplify the impact of cold ambient air temperatures. Provided by the National Weather Service, **Figure 3.25** below shows the relationship of wind speed to apparent temperature and typical time periods for the onset of frostbite.

Figure 3.25 Wind Chill Chart



Source: National Weather Service, <http://www.nws.noaa.gov/om/winter/windchill.shtml>

Winter storms, cold, frost and freeze take a toll on crop production in the planning area. According to the USDA’s Risk Management Agency, payments for insured crop losses in the planning area as a result of winter storm and cold conditions from 2005 to 2015 totaled \$660,845.00.

Table 3.38 Crop Insurance Claims Paid in Marion County as a Result of Cold Conditions and Snow

Crop Year	Crop Name	Cause of Loss Description	Insurance Paid
2005	Wheat	Cold Winter	\$403.00
2005	Wheat	Cold Winter	\$4,285.00
2005	Wheat	Cold Winter	\$28.00
2005	Wheat	Cold Winter	\$682.00
2005	Wheat	Cold Wet Weather	\$4,362.00
2005	Corn	Cold Wet Weather	\$204.00
2005	Grain Sorghum	Frost	\$1,391.00
2006	Corn	Cold Wet Weather	\$2,660.00
2006	Soybeans	Cold Winter	\$176.00
2006	Soybeans	Cold Wet Weather	\$15,458.00
2006	Soybeans	Cold Wet Weather	\$1,008.00
2007	Wheat	Frost	\$4,748.00
2008	Wheat	Freeze	\$798.00
2008	Wheat	Cold Winter	\$1,146.00
2008	Corn	Cold Wet Weather	\$845.00
2008	Soybeans	Cold Wet Weather	\$1,964.00
2009	Wheat	Cold Winter	\$3,030.00



2009	Wheat	Cold Winter	\$13,345.00
2009	Wheat	Cold Winter	\$2,682.00
2009	Wheat	Cold Winter	\$923.00
2009	Wheat	Cold Winter	\$165.00
2009	Wheat	Cold Wet Weather	\$26,257.00
2009	Wheat	Cold Wet Weather	\$35,605.00
2009	Wheat	Cold Wet Weather	\$3,448.00
2009	Wheat	Cold Wet Weather	\$9,544.00
2009	Wheat	Cold Wet Weather	\$2,754.00
2009	Corn	Cold Winter	\$14,586.00
2009	Corn	Cold Wet Weather	\$1,810.00
2009	Grain Sorghum	Frost	\$3,999.00
2009	Grain Sorghum	Frost	\$1,383.00
2009	Soybeans	Cold Wet Weather	\$396.00
2010	Wheat	Cold Wet Weather	\$2,413.00
2010	Wheat	Cold Wet Weather	\$13,558.00
2010	Wheat	Cold Wet Weather	\$1,736.00
2010	Wheat	Cold Wet Weather	\$1,361.00
2010	Corn	Cold Wet Weather	\$6,444.00
2011	Wheat	Cold Winter	\$4,816.00
2011	Wheat	Cold Wet Weather	\$8,871.00
2011	Corn	Cold Wet Weather	\$832.00
2011	Corn	Cold Wet Weather	\$49,063.00
2012	Wheat	Cold Wet Weather	\$870.00
2013	Corn	Cold Wet Weather	\$11,904.00
2013	Soybeans	Cold Wet Weather	\$167.00
2014	Wheat	Freeze	\$11,056.00
2014	Wheat	Freeze	\$7,590.00
2014	Wheat	Cold Winter	\$159,414.00
2014	Wheat	Cold Winter	\$24,346.00
2014	Wheat	Cold Winter	\$1,002.00
2014	Wheat	Cold Winter	\$27,395.00
2014	Wheat	Cold Wet Weather	\$28,683.00
2014	Wheat	Cold Wet Weather	\$19,721.00
2014	Soybeans	Frost	\$8,670.00
2014	Soybeans	Cold Wet Weather	\$7,043.00
2014	Soybeans	Cold Wet Weather	\$4,090.00
2015	Wheat	Cold Winter	\$8,745.00
2015	Wheat	Cold Wet Weather	\$4,881.00
2015	Corn	Cold Wet Weather	\$72,569.00
2015	Soybeans	Cold Wet Weather	\$8,573.00
2015	Soybeans	Cold Wet Weather	\$4,947.00
Total			\$660,485.00

Source: USDA Risk Management Agency, <http://www.rma.usda.gov/data/cause.htm>

## Previous Occurrences

**Table 3.39 NCDC Marion County Winter Weather Events Summary, (January 2005 – December 2015)**

Type of Event	Inclusive Dates	# of Injuries	Property Damages	Crop Damages
Winter Storm	12/08/2005	0	0	0
Winter Storm	11/29/2006	0	0	0
Winter Storm	12/01/2006	0	0	0
Ice Storm	01/12/2007	0	0	0
Winter Weather	12/01/2007	0	0	0
Winter Weather	12/06/2007	0	0	0
Cold/Wind Chill	01/01/2010	0	0	0
Winter Weather	01/06/2010	0	0	0
Heavy Snow	02/21/2010	0	0	0
Winter Storm	01/31/2011	0	0	0
Winter Storm/Blizzard	02/01/2011	0	0	0
Ice Storm	12/08/2012	0	0	0
Heavy Snow	02/07/2013	0	0	0
Heavy Snow	03/24/2013	0	0	0
Winter Storm	02/21/2013	0	0	0
Winter Storm	12/21/2013	0	0	0
Cold/Wind Chill	01/06/2014	0	0	0
Winter Storm	02/04.2014	0	0	0
Heavy Snow	02/20/2015	0	0	0

Source: NCDC, data accessed March 22, 2016

The following section provides additional information for some of the winter storm and ice storm events that have impacted Marion County:

- February 1 & 2, 2011--** The first true blizzard in many years hit from Central to Northeast Missouri. Up to 20 inches of snow fell along with winds gusting over 40 mph. For many counties it was a record snowfall event. The National Guard was called out to help clear County roads and assist with emergency transportation. The region was brought to a standstill for several days. A Federal disaster declaration was obtained for many counties in order to assist with the cost of snow removal. Light freezing rain and sleet started to fall on Monday 1/31 with an inch of sleet accumulating by the early morning hours of Tuesday (2/1). By midday Tuesday (2/1) the precipitation had changed to snow and the wind started to increase. I-70 was shut down from Warren County to just east of Kansas City about 8 pm that evening. The snow tapered off to flurries by Wednesday (2/2) morning. The strong wind continued through the day producing very cold wind chill values.
- January 1 -12, 2010-** The first twelve days of January 2010 was one of the coldest outbreaks in many years. For some locations, it was the first time the temperature dropped below zero in about 10 years. For St. Louis, MO, January 1 - 12 was the 7th coldest on record for that time period. Some of the coldest temperatures observed include Rosebud, MO: -16, Freedom, MO; -12, Lake St. Louis, MO: -11, Washington, MO; -10, Fulton, MO; -9, Fredericktown, MO; -9, Hannibal, MO; - 7, St. Charles, MO; -6, and University City, MO; -1.
- January 6- 7, 2014-** The winter storm that brought heavy snow to much of the area followed that up with the coldest temperatures in 20 years. Some of the temperatures include Rosebud -26, Washington -21, Farmington -15, Hannibal -14, Jefferson City -14, Canton -13, St. Charles -13, Auxvasse -12, Fredericktown -12, Warrenton -12, Clarksville -11, Columbia -11, Chesterfield -11, Potosi -10, Lambert St. Louis International Airport -8. Wind Chill values the morning of the 6th ranged from -25 to -33.

- **February 13, 2007-** An area of low pressure developed over the Texas Panhandle on February 12th and tracked east across Oklahoma and Arkansas on February 13th. Ahead of the storm system, a strong southerly flow produced widespread rain across the St. Louis NWS warning area. As the storm passed to the south and east of the region the rain transitioned to snow. Snowfall ranged from only a trace across the far southern Missouri counties to as much as 10 inches across West Central Illinois. Amounts from Central into Northeast Missouri ranged from 6 to 9 inches.
- **March 24, 2013--** A major spring snowstorm hit the region on Palm Sunday, 3/24/2013. 6 to 11 inches of snow fell across Central, Northeast and East Central Missouri. Thunder snow was reported in many areas with the snow falling at a rate of 2 inches per hour. Since the snow fell from late Saturday night and Sunday, overall impacts were minimal. Most area schools were closed Monday. However since temperatures warmed into the 30s Monday, area roads were in good shape by Monday afternoon.
- **January 12- 14, 2007--**An arctic boundary settled south of the area on the 12th and 13th of January bringing subfreezing temperatures to the northwestern half of the county warning area. Three rounds of precipitation occurred during this period, with the first being the most destructive of all. Significant tree and limb damage was reported as a result of this storm, together with widespread power outages. More than 100,000 homes and businesses lost power during this storm. About 1.5 inches of sleet fell and a 1/2 inch of ice accumulation hit parts of Central and Northeast Missouri. From 1/4 to 1/2 inch of ice accumulated from freezing rain across Eastern Missouri and parts of Southwest Illinois. Flooding of low lying areas and low water crossings occurred across the eastern Ozarks late Friday night and Saturday morning. One fatality occurred in St. Francois County when a man attempted to cross a flooded roadway. The damage figures listed for the various counties are for public assistance only.
- **December 8-12, 2007--** A major ice storm hit parts of central, northeast, and east central Missouri. Up to a half inch of ice accumulated along with up to one inch of sleet. Trees and power lines were down throughout the area. Many businesses had to close due to loss of electricity. Schools across the area were closed for several days. Some power outage numbers include the following: Moniteau County had 10,000 outages including virtually all of California, MO; Callaway County had between 8000 and 10,000 outages; Lincoln County had between 6000 and 7000 outages; Pike County had between 4000 and 5000 outages including almost all of Louisiana, MO. In Boone County, the cities of Hartsburg, Ashland, and Holts Summit all lost power. Shelters were opened in Cole, Pike and Warren Counties. From 50 to 60 people stayed at the shelters in Cole County at various times with over 100 coming in daily for hot meals. There were two fatalities reported in automobile accidents across mid-Missouri.
- **December 8, 2005--** The first significant winter storm of the season hit the area dropping from 2 to around 6 inches of snow. Most of Central Missouri picked up about 2 inches, East Central and Southeast Missouri saw 2 - 4 inches, and Northeast Missouri received from 2 to near 6 inches. Two men were found dead outside in St. Louis. The St. Louis medical examiner ruled hypothermia the cause of both deaths.
- **December 1, 2006--**A major winter storm hit Central, Northeast, East Central and parts of Southeast Missouri from November 30 through December 1. Over a foot of snow fell across parts of Central Missouri while a major ice storm hit parts of East Central and Southeast Missouri, including the St. Louis area. Ice accumulations of 1 inch or more downed trees and power lines resulting in at least 300,000 electric customers losing service for up to a week. Downed limbs and trees damaged homes and automobiles across the area as well. Many rural schools were closed for several days due to slick roads and power outages. The National Guard was called out to several counties to assist with debris removal and other emergency services. In the City of St. Louis the National Guard

went door-to-door to check on residents who had lost power. Damages across the region were expected to be in excess of \$100 million. Following is a summary of how the storm affected various counties. Boone County: Several carports at an apartment complex collapsed from the weight of the snow. Callaway County: A dairy farmer lost 23 head of cattle and other equipment due to roofs collapsing from the weight of the snow. There were several other reports of roofs collapsing on barns and greenhouses. Cole County: Two state office buildings had to be evacuated because their roofs were sagging from the weight of the snow. County officials estimated they spent over \$100,000 in dealing with the storm. Franklin County: The roof of a lumber store in New Haven collapsed from the weight of the ice and snow. Iron County: Power was estimated to be out for about 1/2 of the residents of the county. Schools were closed into the middle of next week. Jefferson County: One person was treated for carbon monoxide poisoning. Moniteau County: The roofs of three turkey barns collapsed due to the weight of the snow. With an estimated 1,000 turkeys per barn, damages will likely be near \$100,000. Monroe County: One person was killed in a storm related traffic accident. Osage County: The roof of a turkey barn collapsed with approximately 10,500 turkeys inside. St. Charles County: About a dozen marinas along the Mississippi River were damaged by the snow and ice. At least 250 boats sustained damage. Damage was estimated at \$15 million. St. Francois County: At least 80% of the county lost power from the storm. One person died in a traffic accident and a man was found dead in his backyard, although the exact cause was not known. Three people were treated for carbon monoxide poisoning. Local officials reported that the total clean up cost in the county would exceed \$200,000. City of St. Louis: Two men died from carbon monoxide poisoning in a garage while trying to stay warm. They had started a fire using charcoal and apparently fell asleep. 11 other people were treated for carbon monoxide poisoning while 53 were treated for hypothermia. Numerous roofs and automobiles were damaged by falling limbs and trees. St. Louis County: Officials reported 40 people treated for carbon monoxide poisoning and 13 treated for hypothermia. One person was injured at a gas station when a canopy collapsed. Numerous roofs and automobiles were damaged from downed tree limbs. Washington County: Officials reported seven people suffered from carbon monoxide poisoning. The City of Potosi lost water service for a couple of days due to the power outage.

- **January 31, 2011**--The first true blizzard in many years hit from Central to Northeast Missouri. Up to 20 inches of snow fell along with winds gusting over 40 mph. For many counties it was a record snowfall event. I-70 was shut down from Warren County to just east of Kansas City. The National Guard was called out to help clear County roads and assist with emergency transportation. The region was brought to a standstill for several days. A Federal disaster declaration was obtained for many counties in order to assist with the cost of snow removal. Light freezing rain and sleet started on Monday 1/31 with an inch of sleet accumulating by the early morning hours of Tuesday (2/1). By midday Tuesday (2/1) the precipitation had changed to snow and the wind began increasing. By late Tuesday (2/1) afternoon travel became extremely dangerous. In the St. Louis Metro area from 2 - 3 inches of sleet fell followed by 2 to 3 inches of snow. Further south sleet accumulations ranged from 1 to 2 inches with from 1/2 to 3/4 inch of ice accumulation due to freezing rain.
- **February 1, 2011**-- The first true blizzard in many years hit from Central to Northeast Missouri. Up to 20 inches of snow fell along with winds gusting over 40 mph. For many counties it was a record snowfall event. The National Guard was called out to help clear County roads and assist with emergency transportation. The region was brought to a standstill for several days. A Federal disaster declaration was obtained for many counties in order to assist with the cost of snow removal. Light freezing rain and sleet started to fall on Monday 1/31 with an inch of sleet accumulating by the early morning hours of Tuesday (2/1). By midday Tuesday (2/1) the precipitation had changed to snow and the wind started to increase. I-70 was shut down from Warren County to just east of Kansas City about 8 pm that evening. The snow tapered off to flurries by Wednesday (2/2) morning. The strong wind continued through the day producing very cold wind chill values. Within the City of Hannibal 24 inches of snowfall with ice and freezing temperatures, community business activity was shutdown for roughly 3 days and all roads were impassable for 1 – 3 days.

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## **Probability of Future Occurrence**

According to NCDC, during the 10 –year period from January 2005 to December 2015, the planning area experienced eight winter storm/blizzard events, two ice storm events, three winter weather, two cold/wind chill events and four heavy snow events. This translates to an annual probability of approximately 1.9 per year a winter weather event will occur.

## **Vulnerability**

### ***Vulnerability Overview***

The entire planning area is vulnerable to the effects of winter storm/blizzard, ice storms, winter weather, cold/wind chill and heavy snow. All effects of winters tend to make driving more treacherous and can impact the response of emergency vehicles. The probability of utility and infrastructure failure increases during winter weather due to the freezing rain accumulation on utility poles and power lines. Elderly populations are considered particularly vulnerable to the impacts of winter weather.

The method used to determine vulnerability to severe winter weather across the planning area was statistical analysis of data from several sources: National Climatic Data Center (NCDC) storm events (1995 to 2015) and Crop Insurance Claims data from USDA’s Risk Management Agency (1995 to 2015).

### ***Potential Losses to Existing Development***

Marion County has a very old downtown district that is comprised of buildings with overhanging tree limbs that are more vulnerable to damage during winter storms. The loss of income is experienced by existing businesses due to power outages. In general heavy winter storms increase the wear and tear on roadways though the cost of such damages is difficult to determine.

### ***Future Development***

Future development could potentially increase vulnerability to this hazard by increasing demand on the utilities and increasing the exposure of infrastructure networks. Currently the Moberly Area Community College is expanding their campus in Marion County which will increase the exposure to damage.

### ***Hazard Summary by Jurisdiction***

Although crop loss as a result of severe winter storm occurs more in the unincorporated portions of the planning area, the density of vulnerable populations is higher in the urban areas of the planning areas. So, it is considered that the magnitude of this hazard is relatively equal. The factors of probability, warning time, and duration are also equal across the planning area. Therefore, the conclusion is that the hazard does not substantially vary by jurisdiction. Located in the planning area is one mobile home park that has become completely isolated at times due to winter storms. No damage to schools was indicated on the data questionnaire.

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**Problem Statement**

Marion County does not have adequate shelters for residents in the event of a winter storm, roads can become hazardous for motorists and emergency responders, power lines can break from ice accumulation and not everyone utilizes social media or texting.

Education needs to occur to ensure all residents are aware of the shelters in the County, residents are educated on emergency supplies to have and the utilization of social media and texting increases.



## 4 MITIGATION STRATEGY

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**44 CFR Requirement §201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.**

This section presents the mitigation strategy updated by the Mitigation Planning Committee (MPC) based on the [updated] risk assessment. The mitigation strategy was developed through a collaborative group process. The process included review of [updated] general goal statements to guide the jurisdictions in lessening disaster impacts as well as specific mitigation actions to directly reduce vulnerability to hazards and losses. The following definitions are taken from FEMA's *Local Hazard Mitigation Review Guide (October 1, 2012)*.

- **Mitigation Goals** are general guidelines that explain what you want to achieve. Goals are long-term policy statements and global visions that support the mitigation strategy. The goals address the risk of hazards identified in the plan.
- **Mitigation Actions** are specific actions, projects, activities, or processes taken to reduce or eliminate long-term risk to people and property from hazards and their impacts. Implementing mitigation actions helps achieve the plan's mission and goals.

### 4.1 Goals

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

This planning effort is an update to Marion County's existing hazard mitigation plan approved by FEMA on June 23, 2011. Therefore, the goals from the 2011 Marion County Hazard Mitigation Plan were reviewed to see if they were still valid, feasible, practical, and applicable to the defined hazard impacts. These goals are listed below:

- 1- Protect the lives and livelihoods of all the citizens
- 2- Decrease the impact of natural hazards
- 3- Ensure continued operation of government and emergency function in a disaster

The MPC conducted a discussion session during the first meeting to review and update the plan goals. To ensure that the goals developed for this update were comprehensive and supported State goals, the

2013 State Hazard Mitigation Plan goals were reviewed. It was determined the broadly stated purposes were still valid for the 2016 update.

## 4.2 Identification and Analysis of Mitigation Actions

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

Members of the MPC reviewed the results of the risk assessment and the key issues were discussed. Changes in risk since adoption of the previously approved plan was reviewed by the MPC also. The MPC reviewed SEMA's identified funding priorities and the types of mitigation actions generally recognized by FEMA that was provided to them at the first meeting.

The MPC determined to include problem statements in the plan update at the end of each hazard profile, which had not been done in the previously approved plan. The problem statements summarize the risk to the planning area presented by each hazard, and include possible methods to reduce that risk. Use of the problem statements allowed the MPC to recognize new and innovative strategies for mitigate risks in the planning area.

The MPC reviewed updating the mitigation strategy. For a comprehensive range of mitigation actions to consider, the MPC reviewed the following information:

- A list of actions proposed in the previous mitigation plan, the current State Plan, and approved plans in surrounding counties,
- Key issues from the risk assessments, including the Problem Statements concluding each hazard profile and vulnerability analysis,
- State priorities established for Hazard Mitigation Assistance grants, and
- Public input during meetings, responses to Data Collection Questionnaires, and other efforts to involve the public in the plan development process.

Individual jurisdictions, including schools were encouraged to propose new mitigation strategies. They were encouraged to review the details of the risk assessment vulnerability analysis specific to their jurisdiction.

Each jurisdiction reviewed the actions from the previously approved plan using the STAPLEE format.

Based on input from the jurisdictions and status updates, there were 19 completed actions, 53 deleted actions, 13 continuing actions and one new action.

**Table 4.1** provides a summary of the completed and deleted actions from the previous plan.

**Table 4.1 Summary of Completed and Deleted Actions from the Previous Plan**

Completed Actions	Completion Details (date, amount, funding source)
<b>Marion County</b>	
Evaluate and upgrade as needed the current	The County completed the new 911 facility and

emergency response communications infrastructure.	updated the GIS system.
Obtain sufficient back-up generators to maintain communications for all emergency personnel.	The County has identified a sufficient number of generators to meet the needs of emergency personnel.
Education brochures provided to schools and citizens.	Education brochures were developed and provided to schools and citizens.
Study the possibility of establishing permanent location as EOC, fully equipped communications systems.	EOC in place.
Maintain Mutual Aid Agreements and update on a regular schedule.	All mutual aid agreements are up to date and enforce.
Update Emergency Operating Plan on a regular schedule.	Emergency Operating Plan is up to date and enforce.
Educational brochures on what to do during a tornado or severe storm.	Educational brochures were developed and are distributed on a regular basis.
Encourage more river level gauges and real time monitoring along the North River, South Fabius River, and the North Fabius river.	This action is ongoing.
Make design/construction awareness brochures available.	Brochures are continually updated and provided with new building permits.
Conduct regularly scheduled training for weather spotters.	Training is held on an annual basis.
<b>City of Hannibal</b>	
Evaluate and upgrade as needed the current emergency response communications infrastructure.	Completely new 911 system along with a Code Red System.
Obtain sufficient back-up generators to maintain communications for emergency personnel.	Obtained generators for emergency personnel
Education brochures provided to schools and citizens.	City has completed all requested tasks for this action.
Cooperated with county to establish permanent location as Emergency Operation Center.	EOC in place.
Training and certification of Emergency Management Director.	Has completed all training and certification.
Investigate possible ordinance to require mobile home parks to have on-site storm shelter.	City has completed all requested tasks for this action.
Establish Emergency Management Director position	Personnel is in place for this action.

for the city.	
Maintain Mutual Aid Agreements and update on a regular schedule.	All mutual aid agreements are up to date and enforce.
Current Buyout Program.	Buyout has been completed.

Deleted Actions	Reason for Deletion
<b>Marion County</b>	
Maintain and replace missing street signs.	This was determined to be a daily or as necessary activity and not a mitigation activity.
Maintain transportation infrastructure.	This was determined to be a daily or as necessary activity and not a mitigation activity.
Training and certification of Emergency Management Director.	This was determined to be a daily or as necessary activity and not a mitigation activity.
Investigate the possibility of constructing a fireproof, waterproof, and earthquake proof storage building for all county records.	This was determined not to be a mitigation activity.
Insure all school buses radios are in communication with 911.	All school buses are equipped with cell phones and have communication with 911.
Update and maintain list of buildings that are designated as shelters and distribute list.	This was determined to be a daily or as necessary activity and not a mitigation activity.
Distributed information on how to retrofit windows in schools, daycares and nursing homes.	This was determined not to be a mitigation activity.
Develop a protocol for "All Clear" for all warning sirens in the County.	This was determined to be a daily or as necessary activity and not a mitigation activity.
Engage field inspector to look for new construction within the floodplain.	This was determined to be a daily or as a necessary activity and not a mitigation activity.
Maintain Levee Districts.	This action was duplicated.
Set up a committee within Marion County consisting of Floodplain Manager, Representatives of Levee Districts, Planning and Zoning Commission, EMD and City of Hannibal to develop a Comprehensive Flood Management Plan for Marion County.	This was determined to be a daily or as a necessary activity and not a mitigation activity.
Work with the UMIMRA (Upper Mississippi, Illinois & Missouri Rivers Association) to provide information to local, state and federal agencies on flood mitigation issues within Marion County and improvements of the levee systems.	This was determined to be a daily activity and not a mitigation activity.
Remove trees from power line easements in	This was determined to be a daily or as a necessary

addition to current trimming program.	activity and not a mitigation activity.
Maintain snow plowing and removal equipment.	This was determined to be a daily or as a necessary activity and not a mitigation activity.
Insure that county school buses are outfitted with two way radios.	All school buses are equipped with cell phones and have communication with 911.
Have a speaker available to conduct programs on earthquake safety.	This was determined to not be necessary.
Informational brochures available to public, newspaper articles.	This was determined to be daily activity and not a mitigation activity.
Participate in regularly scheduled training exercises.	This was determined to be a daily or as a necessary activity and not a mitigation activity.
Establish cooling center.	This was determined to not be a mitigation activity.
Burning bans issued by County Commission and Rural Fire Departments as needed.	This was determined to be a daily or as a necessary activity and not a mitigation activity.
Highway Dept. monitors and address problem areas as needed.	This was determined to be a daily or as a necessary activity and not a mitigation activity.
Promote use of NOAA radios in schools, nursing homes, businesses, private homes, and large gatherings.	Duplication of previous action item.
<b>City of Hannibal</b>	
Maintain transportation infrastructure.	Basic maintenance function that doesn't need to be documented for emergency management.
Educational brochure on what to do during a tornado or severe storm.	Creates confusion to citizens.
Investigate need for additional warning sirens to cover the western expansion of the city areas of inadequate coverage.	Marion County function; not relevant to city.
Promote use of NOAA radios in schools, nursing homes, businesses, private homes and large gatherings.	Is a 100% duplication of AH #2, which remains a viable action.
Maintain & replace missing street signs.	Basic maintenance function that doesn't need to be documented for emergency management.
Alpha-numeric pagers for all police & firefighters for mass call-out.	Basic maintenance function that doesn't need to be documented for emergency management.
Work with local cable TV company to post severe natural hazards announcements.	This was determined to be a daily or as a necessary activity and not a mitigation activity.
Update Emergency Operating Plan on a regular	This was determined to be a daily or as a necessary

schedule.	activity and not a mitigation activity.
Install video surveillance on all buses.	School function; not relevant to the city.
Increase public awareness of responsibility to have a family plan for safety in place by add information to city webpage, brochures available at United Way, Red Cross, City Hall, Citizen Corp, NEMOready.org	This was determined not to be a mitigation activity.
Update and maintain list of buildings that are designated as "after the event" shelters, distribute list.	This was determined not to be a mitigation activity.
Distributed information on how to retrofit windows in schools, daycares, and nursing homes.	This was determined to not be a necessary mitigation activity.
Engage field inspector to look for new construction within the floodplain.	This was determined to be a daily or as a necessary activity and not a mitigation activity.
Regularly scheduled cleanup of Bear Creek to mitigate flash flood.	This was determined to be a daily or as a necessary activity and not a mitigation activity.
Increase public awareness. Add information to city webpage. Brochures available at United Way, Red Cross, City Hall, Citizen Corp, NEMOready.org	This was determined to be a daily or as a necessary activity and not a mitigation activity.
Repetitive flood loses. Red Cross maintains list of FEMA request for repetitive flood loses.	This was determined to be a daily or as a necessary activity and not a mitigation activity.
Put up street barricades as needed when threatened by high water.	This was determined to be a response action and not a mitigation activity.
Determine which shelters would be available during winter weather. Update list and distribute to emergency personnel.	This was determined not to be a mitigation activity.
Establish cooling centers.	This was determined not to be a mitigation activity.
Encourage drought resistant yard watering practices.	This was determined not to be a mitigation activity.
Ensure availability of fans to be distributed as needed.	This was determined not to be a mitigation activity.
Encourage schools to conduct programs on earthquake safety.	School function; not relevant to the city.
Have speaker available to conduct programs on earthquake safety.	This was determined not to be a mitigation activity.
Use HAZUS software to identify potential loss due to earthquakes.	This was determined not to be a mitigation activity.
Informational brochures available to public, newspaper articles.	This was determined not to be a mitigation activity.



Participate in regularly scheduled training exercise.	This was determined not to be a mitigation activity.
Enforcement of current building codes.	This was determined not to be a mitigation activity.
Burning bans issued by Fire Departments as needed.	This was determined to be a response action and not a mitigation activity.
Personal fireworks are banned in city limits.	This was determined not to be a mitigation activity.
Personal trash burning restrictions in place, must obtain a permit to burn trash in city limits.	This was determined not to be a mitigation activity.
City has a collection center for yard waste.	This was determined not to be a mitigation activity.

### 4.3 Implementation of Mitigation Actions

**44 CFR Requirement §201.6(c)(3)(ii): The mitigation strategy shall include an action strategy describing how the actions identified in paragraph (c)(2)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefits review of the proposed projects and their associated costs.**

Jurisdictional MPC members were encouraged to meet with others in their community to finalize the actions to be submitted for the updated mitigation strategy. Throughout the MPC consideration and discussion, emphasis was placed on the importance of a benefit-cost analysis in determining project priority. The Disaster Mitigation Act requires benefit-cost review as the primary method by which mitigation projects should be prioritized. The MPC decided to pursue implementation according to when and where damage occurs, available funding, political will, jurisdictional priority, and priorities identified in the Missouri State Hazard Mitigation Plan. The benefit/cost review at the planning stage primarily consisted of a qualitative analysis, and was not the detailed process required grant funding application. For each action, the plan sets forth a narrative describing the types of benefits that could be realized from action implementation. The cost was estimated as closely as possible, with further refinement to be supplied as project development occurs.

FEMA's suggested STAPLEE methodology is used follows: FEMA's STAPLEE methodology was used to assess the costs and benefits, overall feasibility of mitigation actions, and other issues impacting project. During the prioritization process, the MPC used worksheets to assign scores. The worksheets posed questions based on the STAPLEE elements as well as the potential mitigation effectiveness of each action. Scores were based on the responses to the questions as follows:

Definitely yes = 3 points  
 Maybe yes = 2 points  
 Probably no = 1  
 Definitely no = 0

The following questions were asked for each proposed action.

- S: Is the action socially acceptable?
- T: Is the action technically feasible and potentially successful?
- A: Does the jurisdiction have the administrative capability to successfully implement this action?
- P: Is the action politically acceptable?
- L: Does the jurisdiction have the legal authority to implement the action?
- E: Is the action economically beneficial?

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E: Will the project have an environmental impact that is either beneficial or neutral? (score “3” if positive and “2” if neutral)

Will the implemented action result in lives saved?

Will the implanted action result in a reduction of disaster damage?

The final scores are listed below in the analysis of each action. The worksheets are included in this plan. The STAPLEE final score for each action, absent other considerations, such as a localized need for a project, determined the priority. Low priority action items were those that had a total score of between 0 and 24. Moderate priority actions were those scoring between 25 and 29. High priority actions scored 30 or above. A blank STAPLEE worksheet is shown in Figure 4.1

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**Figure 4.1. Blank STAPLEE Worksheet**

**XXXXXX COUNTY  
MULTI-JURISDICTIONAL  
LOCAL HAZARD MITIGATION PLAN**

<b>Action Title:</b>		<b>Jurisdiction:</b>	
<b>Action ID:</b>			
STAPLEE Criteria	Evaluation Rating Definitely YES = 3 Maybe YES = 2 Probably NO = 1 Definitely NO = 0	Score	
S: Is it Socially acceptable?			
T: Is it Technically feasible and potentially successful?			
A: Does the jurisdiction have the administrative capacity to execute this action?			
P: Is it Politically acceptable?			
L: Is there Legal authority to implement?			
E: Is it Economically beneficial?			
E: Will the project have either a neutral or positive impact on the natural environment? (score a 3 if positive impact, 2 if neutral impact)			
Will historic structures be saved or protected?			
Could it be implemented quickly?			
<b>STAPLEE Score</b>			

Mitigation Effectiveness Criteria	Evaluation Rating	Score
Will the implemented action result in lives saved?	Assign from 5-10 points based on the likelihood that lives would be saved.	
Will the implemented action result in a reduction of disaster damages?	Assign from 5-10 points based on the relative reduction of disaster damages.	
<b>Mitigation Effectiveness Score</b>		

Total Score (STAPLEE Score + Mitigation Effectiveness Score): \_\_\_\_\_

Priority Level:  High (30+ points)       Medium (25-29 points)       Low (less than 25 points)

Completed by (name/title/phone #): \_\_\_\_\_





Priority: High  
 Timeline for Implementation/ Completion: 1 major tabletop exercise a year  
 Status of Action: Continuing  
 Report of Progress: Annually after exercise

**Action No:** MCHM1606  
**Description:** Prepare and distribute letter to private landowners with dams, urging them to regularly inspect and maintain their dams to MO DNR standards, explaining the importance, and providing applicable DNR contact (or standards) information in the letter.

Jurisdictions Selecting the Action: Marion County The City of Hannibal  
 Responsible Agency/Party: County Coordinator EMD  
 Problem to be Mitigated: If private property owners do not maintain their private dams, breeches in lake dams and other dams could have a devastating effect on downgradient property owners.

Applicable Goal(s): Goal 1: Protect the lives and livelihoods of all the citizens  
 Hazards Addressed: DF  
 Estimated Cost: \$50.00  
 Potential Funding Sources: County/City General Fund  
 Cost/Benefit Discussion: This was not discussed  
 Prioritization Discussion: Average STAPLEE Score 33.50  
 Priority: High  
 Timeline for Implementation/ Completion: 2017  
 Status of Action: Continuing Not Started  
 Report of Progress: Annual Report

**Action No:** MCHM1607  
**Description:** Urge schools to educate their students on earthquake safety, and provide written materials that help that education process

Jurisdictions Selecting the Action: Marion County The City of Hannibal  
 Responsible Agency/Party: County Coordinator EMD  
 Problem to be Mitigated: If school staff and school children are unaware how to act/respond during an earthquake, lives could needlessly be lost

Applicable Goal(s): Goal 1: Protect the lives and livelihoods of all the citizens  
 Goal 2: Decrease the impact of natural hazards.  
 Hazards Addressed: EQ  
 Estimated Cost: \$1,000.00  
 Potential Funding Sources: County/City Fund  
 Cost/Benefit Discussion: This was not discussed  
 Prioritization Discussion: Average STAPLEE Score 33  
 Priority: High  
 Timeline for Implementation/ Completion: 2016  
 Status of Action: Continuing Not Started  
 Report of Progress: Annually

**Action No:** MCHM1608  
**Description:** Review land use ordinances and modernize/update based in changing trends and market demands.

Jurisdictions Selecting the Action: Marion County The City of Hannibal  
 Responsible Agency/Party: Marion County The City of Hannibal



Problem to be Mitigated:	County Coordinator	Building Inspector
Applicable Goal(s):	Goal 1: Protect the lives and livelihoods of all the citizens	
Hazards Addressed:	RF, EQ, F U	
Estimated Cost:	\$0	
Potential Funding Sources:	No funding necessary; only human action required	
Cost/Benefit Discussion:	This action did not require funding	
Prioritization Discussion:	Average STAPLEE Score of 29.50	
Priority:	Medium	
Timeline for Implementation/ Completion:	2016	
Status of Action:	Continuing	
Report of Progress:	Annual Report	

**Action No:**  
**Description**

**MCHM1609**

**Procure necessary generators to serve as backup power supply for “after event” shelters. Can access Troop B generators as needed, but ownership would provide greater dependability. Obtain a list of approved Red Cross shelters within the county. Review land use ordinances and modernize/update based in changing trends and market demands.**

Jurisdictions Selecting the Action:	Marion County	The City of Hannibal
Responsible Agency/Party:	County EMD	EMD
Problem to be Mitigated:	Certain sheltering locations lack backup power sources, making them (and the people they serve) vulnerable to uncontrollables.	

Applicable Goal(s):	Goal 1: Protect the lives and livelihoods of all the citizens
	Goal 3: Ensure continued operation of government and emergency function in a disaster. Goal 1: Protect the lives and livelihoods of all the citizens

Hazards Addressed:	RF LF DQ ST T SWW ET F A PH TX U
Estimated Cost:	\$50,000.00
Potential Funding Sources:	Region B RHSOC/ City General Fund
Cost/Benefit Discussion:	This was not discussed
Prioritization Discussion:	Average STAPLEE Score 24
Priority:	Low
Timeline for Implementation/ Completion:	2017
Status of Action:	Continuing
Report of Progress:	Annually

**Action No:**  
**Description**

**MCHM1610**

**Identify populated areas in the county and secure funding to purchase warning sirens.**

Jurisdictions Selecting the Action:	Marion County
Responsible Agency/Party:	County Coordinator
Problem to be Mitigated:	Unincorporated areas of the county lacks warning sirens.
Applicable Goal(s):	Goal 1: Protect the lives and livelihoods of all the citizens.
Hazards Addressed:	T
Estimated Cost:	\$26,000.00
Potential Funding Sources:	General Revenue, RHSOC Grants
Cost/Benefit Discussion:	This was not discussed
Prioritization Discussion:	STAPLEE Score of 38
Priority:	High
Timeline for Implementation/ Completion:	2020
Status of Action:	Continuing
Report of Progress:	Annually

<p><b>Action No:</b> <b>Description</b></p> <p>Jurisdictions Selecting the Action: Responsible Agency/Party: Problem to be Mitigated:</p> <p>Applicable Goal(s): Hazards Addressed: Estimated Cost: Potential Funding Sources: Cost/Benefit Discussion: Prioritization Discussion: Priority: Timeline for Implementation/ Completion: Status of Action: Report of Progress:</p>	<p><b>MCHM1611</b> <b>Identify trailer parks in need of storm shelters and secure funding to construct the shelters.</b></p> <p>Marion County County Coordinator Trailer parks lack shelter that can withstand the destruction of a tornado. Goal 1: Protect the lives and livelihoods of all the citizens. T Unknown Emergency Preparedness Grants This was not discussed STAPLEE Score of 37 High 5 years Continuing Annually</p>
<p><b>Action No:</b> <b>Description</b></p> <p>Jurisdictions Selecting the Action: Responsible Agency/Party: Problem to be Mitigated: Applicable Goal(s):</p> <p>Hazards Addressed: Estimated Cost: Potential Funding Sources: Cost/Benefit Discussion: Prioritization Discussion: Priority: Timeline for Implementation/ Completion: Status of Action: Report of Progress:</p>	<p><b>MCHM1612</b> <b>Agencies will work together to provide updated floodplain maps.</b></p> <p>Marion County County Coordinator Floodplain maps are not up to date Goal 1: Protect the lives and livelihoods of all the citizens. Goal 2: Decrease the impact of natural hazards. F \$0 No funding necessary; only human action required This action did not require funding STAPLEE Score of 30 High 2020 Continuing Annual Report</p>
<p><b>Action No:</b> <b>Description</b></p> <p>Jurisdictions Selecting the Action: Responsible Agency/Party: Problem to be Mitigated: Applicable Goal(s): Hazards Addressed: Estimated Cost: Potential Funding Sources: Cost/Benefit Discussion: Prioritization Discussion: Priority: Timeline for Implementation/ Completion: Status of Action: Report of Progress:</p>	<p><b>MCHM1613</b> <b>Actively research and promote drought resistant farming practices to farmers in the county.</b></p> <p>Marion County County Coordinator Farmers suffering major losses during droughts. Goal 2: Decrease the impact of natural hazards. D \$1,000.00 County General Revenue Fund This was not discussed STAPLEE Score of 24 Low 2020 Continuing Annually</p>

<b>Action No:</b>	<b>MCHM1614</b>
<b>Description</b>	<b>A safe room/storm shelter will be constructed to protect individuals in the school and community.</b>
Jurisdictions Selecting the Action:	Palmyra School District
Responsible Agency/Party:	Palmyra R-1
Problem to be Mitigated:	Injury and death resulting from the destructive wind storms of tornados.
Applicable Goal(s):	Goal 1: Protect the lives and livelihood of all the citizens
Hazards Addressed:	ST T
Estimated Cost:	Unknown
Potential Funding Sources:	HMPG, PDN
Cost/Benefit Discussion:	This was not discussed
Prioritization Discussion:	STAPLEE Score of 37
Priority:	High
Timeline for Implementation/ Completion:	2020
Status of Action:	New
Report of Progress:	Annually

### **Marion County Action Worksheets**

The sample action worksheet below was completed by members of the planning committee to determine action items.

<b>Action Worksheet</b>	
Name of Jurisdiction:	Marion County
<b>Risk/Vulnerability</b>	
Problem being Mitigated:	Inability to quickly inform the public of impending disasters or severe weather warnings. Greater advance notice will allow residents and businesses more opportunity to take necessary precautions.
Hazard(s) Addressed:	ST T SWW ET
<b>Action or Project</b>	
Action/Project Number:	MCHM1601
Name of Action or Project:	Promote NOAA Radio acquisition and use by residents and businesses.
Action or Project Description:	Promote NOAA Radio Use – Work on public service announcements (30) seconds to be put on local radio stations. Schools will also post announcements regarding NOAA Radios on their "School Reach" system. All nursing homes in the county have NOAA radios.
Applicable Goal Statement:	Goal 1: Protect the lives and livelihoods of all the citizens
Estimated Cost:	\$0
Benefits:	Provides advance warning to residents of impending severe weather and other environmental/temperature impacts, allowing them advance preparation/planning to prepare and take adequate precautions.
<b>Plan for Implementations</b>	
Responsible Organization/Department:	Emergency Management Department
Action/Project Priority:	STAPLEE score of 39. High priority.
Timeline for Completion:	12 months. Will occur throughout the entire year, annually.
Potential Fund Sources:	No funding necessary; only human action required.
Local Planning Mechanisms to be Used in Implementation, if any:	
<b>Progress Report</b>	
Action Status	Continuing
Report of Progress	Completed regularly throughout the year. Will do so again in 2016, 17, 18 19 and 2020.
Completed by:	Teya Stice, County Coordinator, 573-769-5545

5.0

## 5 PLAN MAINTENANCE PROCESS

<b>5</b>	<b>PLAN MAINTENANCE PROCESS.....</b>	<b>152</b>
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This chapter provides an overview of the overall strategy for plan maintenance and outlines the method and schedule for monitoring, updating and evaluating the plan. The chapter also discusses incorporating the plan into existing planning mechanisms and how to address continued public involvement.

### 5.1 Monitoring, Evaluating, and Updating the Plan

**44 CFR Requirement 201.6(c)(4): The plan maintenance process shall include a section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.**

#### 5.1.1 Responsibility for Plan Maintenance

The Marion County Planning Committee is not a standing committee, and therefore responsibility for maintenance of the plan actions in section 4 will reside with the Jurisdictional Representatives referenced in the chart on page i. These individuals are responsible for seeing that the actions which they have put in the plan are eventually implemented, if possible. These individuals or entities will meet annually as a “plan maintenance committee” with the Marion County Commission to evaluate the implementation of various actions within their jurisdiction. They will also meet after any major disaster event. These individuals will maintain vigilant monitoring of multi-objective, cost-share, and other funding opportunities to help their community or school district implement the plan’s recommended actions for which no current funding exists, and keep the concept of mitigation in the forefront of decision making by identifying plan recommendations when other goals, plans, and activities overlap, influence, or directly affect increased vulnerability to disasters.

Like the planning committee, the maintenance committee is an advisory body and can only make recommendations to county, city, town, or district elected officials. Its primary duty is to see the plan successfully carried out and to report to the community governing boards and the public on the status of plan implementation and mitigation opportunities.

### 5.1.2 Plan Maintenance Schedule

The Marion County Planning Committee agrees to meet annually and after a state or federally declared hazard event as appropriate to monitor progress and update the mitigation strategy. The Marion County Emergency Management Director will be responsible for initiating the plan reviews and will invite members of the Marion County Planning Committee to the meeting.

In coordination with all participating jurisdictions, a five-year written update of the plan will be submitted to the Missouri State Emergency Management Agency (SEMA) and FEMA Region VII per Requirement §201.6(c)(4)(i) of the Disaster Mitigation Act of 2000, unless disaster or other circumstances (e.g., changing regulations) require a change to this schedule.

### 5.1.3 Plan Maintenance Process

Progress on the proposed actions can be monitored by evaluating changes in vulnerabilities identified in the plan.

Future 5-year updates to this plan will include the following activities:

- Consideration of changes in vulnerability due to action implementation,
- Documentation of success stories where mitigation efforts have proven effective,
- Documentation of unsuccessful mitigation actions and why the actions were not effective,
- Documentation of previously overlooked hazard events that may have occurred since the previous plan approval,
- Incorporation of new data or studies with information on hazard risks,
- Incorporation of new capabilities or changes in capabilities,
- Incorporation of growth data and changes to inventories, and
- Incorporation of ideas for new actions and changes in action prioritization.

In order to best evaluate any changes in vulnerability as a result of plan implementation, the participating jurisdictions will adopt the following process:

- Each proposed action in the plan identified an individual, office, or agency responsible for action implementation. This entity will track and report on an annual basis to the jurisdictional MPC (or designated responsible entity) member on action status. The entity will provide input on whether the action as implemented meets the defined objectives and is likely to be successful in reducing risk.
- If the action does not meet identified objectives, the jurisdictional MPC (or designated responsible entity) member will determine necessary remedial action, making any required modifications to the plan.

Changes will be made to the plan to remedy actions that have failed or are not considered feasible. Feasibility will be determined after a review of action consistency with established criteria, time frame, community priorities, and/or funding resources. Actions that were not ranked high but were identified as potential mitigation activities will be reviewed as well during the monitoring of this plan. Updating of the plan will be accomplished by written changes and submissions, as the (MPC or designated responsible entity) deems appropriate and necessary. Changes will be approved by the County "A" Board of (Supervisors or Commissioner) and the governing boards of the other participating jurisdictions.



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## 5.2 Incorporation into Existing Planning Mechanisms

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

For the most part the participating jurisdictions did not incorporate the previously approved mitigation plan into other planning mechanisms due to the other plans already being approved. The City of Hannibal has extensive planning in place and will use those plans to implement hazard mitigation actions where possible. For updated plans there must be an explanation of how the participating jurisdictions incorporated the previously approved mitigation plan into other planning mechanisms as a demonstration of progress in local hazard mitigation efforts.

When possible, Marion County Commission, The City of Hannibal and the Palmyra R-1 School District. Those existing plans and programs were described in Section 2 of this plan. Based on the capability assessments of the participating jurisdictions, communities in Marion County will continue to plan and implement programs to reduce losses to life and property from hazards. This plan builds upon the momentum developed through previous and related planning efforts and mitigation programs and recommends implementing actions, where possible, through the following plans:

- General or master plans of participating jurisdictions;
- Ordinances of participating jurisdictions;
- Marion County Emergency Operations Plan;
- Capital improvement plans and budgets;
- Other community plans within the County, such as water conservation plans, storm water management plans, and parks and recreation plans;
- School and Special District Plans and budgets; and

The Marion County Planning Committee members involved in updating these existing planning mechanisms will be responsible for integrating the findings and actions of the mitigation plan, as appropriate. The Marion County Planning Committee is also responsible for monitoring this integration and incorporation of the appropriate information into the five-year update of the multi-jurisdictional hazard mitigation plan.

Additionally, after the annual review of the Hazard Mitigation Plan, the Marion County Emergency Management Director will provide the updated Mitigation Strategy with current status of each mitigation action to the County (Boards of Supervisors or Commissions) as well as all Mayors, City Clerks, and School District Superintendents. The Emergency Manager Director will request that the mitigation strategy be incorporated, where appropriate, in other planning mechanisms.

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## 5.3 Continued Public Involvement

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

The hazard mitigation plan update process provides an opportunity to publicize success stories resulting from the plan's implementation and seek additional public comment. Information about the annual reviews will be posted in the local newspaper as well as on the Marion County website following each annual review of the mitigation plan. When the MPC reconvenes for the five-year update, it will coordinate with all stakeholders participating in the planning process. Included in this group will be those who joined the MPC after the initial effort, to update and revise the plan. Public notice will be posted and public participation will be actively solicited, at a minimum, through available website postings and press releases to local media outlets, primarily newspapers.